PCDD (DIOXINS) AND PCDF (FURANS): SOURCES AND REGULATIONS
ADDENDUM
AUGUST 18, 2000

The draft of the Great Lakes Binational Toxics Strategy (BTS) Dioxin Step 1&2 report, PCDD (Dioxins) and PCDF (Furans): Sources and Regulations, was finished and prepared for public review on May 26, 2000. In June, 2000, a public release of Dioxin Reassessment draft documents for external scientific review was provided on EPA's website (www.epa.gov/nceawww1/dioxin.htm). The draft documents included revised inventory estimates and information related to estimates of dioxins and furans releases that is not included in, or is different from, that presented in the May 26, 2000 version of the BTS Dioxin Step 1&2 report. A preliminary review of the draft documents revealed several primary areas where new information relevant to the Step 1&2 report is provided in the June 2000 draft Dioxin Reassessment. These include:

- Additional toxic equivalency factor (TEF) schemes are defined and used to present results.
- A revised qualitative confidence rating scheme replaces the use of a numeric range of emissions to characterize uncertainty in the emission estimates.
- Additional detail is provided on congener profiles for certain sources.
- Additional discussion is added on the relationship of chlorine levels in the feed to dioxins/furans emissions for combustion sources.
- Updated release estimates are provided for certain sectors, including preliminary estimates of releases from urban runoff and rural soil erosion.

However, review of the draft documents released in June did not indicate any areas where the qualitative assessment of the relative magnitude of known dioxin sources presented in the May 26, 2000 report would be affected by the new information in the draft documents. The Great Lakes National Program Office (GLNPO) has chosen to release the May 26, 2000 version of the Dioxin Step 1&2 report without making revisions to reflect new information in the Dioxin Reassessment draft documents released in June for the following reasons:

1. While there are many places where individual emission estimates change slightly, the overall qualitative assessment of the relative impact of different sources remains the same and conclusions related to reduction opportunities for the BTS would not be affected.
2. The numbers and information contained in the June 2000 draft documents are only draft and are not to be cited nor referred to as EPA's final reassessment. Revising the report to reflect interim results that are not qualitatively different is not warranted, given that final reassessment inventory numbers should be available within a year.
3. GLNPO is committed to providing the information on sources and regulations contained in the Dioxin Step 1&2 report to its stakeholders as quickly as possible.

Revisions to the report will be reconsidered upon release of the Final Dioxin Reassessment.

Great Lakes Binational Toxics Strategy

PCDD (DIOXINS) AND PCDF (FURANS): SOURCES AND REGULATIONS

Draft Report

Prepared for

U.S. EPA
Great Lakes National Program Office
Contract # 68-W-99-033

Prepared by

Battelle

MAY 26, 2000

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LIST OF ACRONYMS

2,3,7,8-TCDD:	2,3,7,8-tetrachlorodibenzo-p-dioxin
AOC:	Area of Concern
BAT:	Best Available Technology
CAA:	Clean Air Act
CDC:	Center for Disease Control and Prevention
CEC:	North American Commission for Environmental Cooperation
CERCLA:	Comprehensive Environmental Response, Compensation, and Liability Act
CIWI:	Commercial and Industrial Waste Incinerators
CWA:	Clean Water Act
DCI:	Data Call-in
DEI:	Dioxin Exposure Initiative
FDA:	U.S. Food and Drug Administration
FIFRA:	Federal Insecticide, Fungicide, Rodenticide Act
FSIS:	Food Safety Inspection Service
GLBTS:	Great Lakes Binational Toxics Strategy
GLWQA:	Great Lakes Water Quality Agreement
HAP:	Hazardous Air Pollutant
HCB:	Hexachlorobenzene
HCl:	Hydrochloric acid
HMIWI:	Hospital / Medical / Infectious Waste Incinerators
HSWA:	Hazardous and Solid Waste Amendments
HWC:	Hazardous Waste Combustors
IADN:	Integrated Atmospheric Deposition Network
IJC:	International Joint Commission
LaMP:	Lakewide Management Plan
LRTAP:	Long Range Treaty on Air Pollution
MACT:	Maximum Achievable Control Technology
MCL:	Maximum Contaminant Level (Drinking water standard)
MCLG:	Maximum Contaminant Level Goal
MSW:	Municipal Solid Waste
MWC:	Municipal Waste Combustors
NAFTA:	North American Free Trade Agreement
NAS:	National Academy of Sciences
NDAMN:	National Dioxin Ambient Air Monitoring Network
NESHAPS:	National Emissions Standards for Hazardous Air Pollutants (HAPs)
NHANES:	National and Nutrition Examination Survey
NHATS:	National Human Adipose Tissue Survey
NLFWA:	National Listing of Fish and Wildlife Advisories
NPDES:	National Pollutant Discharge Elimination System
NPDWR:	National Primary Drinking Water Regulations
NSPS:	New Source Performance Standards
OAQPS:	EPA's Office of Air Quality Planning and Standards
OPP:	EPA's Office of Pesticide Programs
OPPT:	EPA's Office of Pollution Prevention and Toxic Substances
OPPTS:	EPA's Office of Prevention, Pesticides and Toxic Substances
ORD:	EPA's Office of Research and Development
OSWER:	EPA's Office of Solid Waste and Emergency Response
OSWI:	Other Solid Waste Incinerators
OW:	EPA's Office of Water
PAHs:	Polycyclic aromatic hydrocarbons
PBT:	Persistent Bioaccumulative Toxic

PCB:	Polychlorinated biphenyl
PCDDs:	Polychlorinated dibenzo-p-dioxins (dioxins)
PCDFs:	Polychlorinated dibenzofurans (furans)
PCP:	Pentachlorophenol
PM:	Particulate matter
POP:	Persistent Organic Pollutant
POTW:	Publicly Owned Treatment Works (municipal waste water treatment plant)
PVC:	Polyvinyl chloride
RAP:	Remedial Action Plan
RCRA:	Resource Conservation and Recovery Act
RED:	Re-registration Eligibility Decision Document
RQ:	Reportable Quantity
SARA/EPCRA:	Superfund Amendment Reauthorization Act / Emergency Planning and Community Right-to-know Act
SDWA:	Safe Drinking Water Act
SIC:	Standard Industrial Classification
SMOC:	Sound Management of Chemicals Initiative
TCLP:	Toxicity Characteristic Leachate Procedure
TEF:	Toxicity Equivalency Factor
TEQ:	Toxicity (2,3,7,8-TCDD) Equivalents
TMDL:	Total Maximum Daily Load
TPQ:	Threshold Planning Quantity
TRI:	Toxic Release Inventory
TSCA:	Toxic Substances Control Act
UNEP:	United Nations Environment Programme
USDA:	U.S. Department of Agriculture
WMNP:	Waste Minimization National Plan

L	liter
mg:	milligram
ng:	nanogram
pg:	picogram
ppb:	parts per billion
ppm:	parts per million
ppt:	parts per trillion
ppq:	parts per quadrillion
TEQ:	Toxicity (2,3,7,8-TCDD) Equivalents
μg:	microgram

1.0 INTRODUCTION

On April 7, 1997, Canada and the United States signed the *Great Lakes Binational Toxics Strategy: Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes* (Binational Toxics Strategy or GLBTS). The Binational Toxics Strategy identified twelve bioaccumulative substances having sufficient toxicity and presence in water, sediments and/or aquatic biota of the Great Lakes system to warrant concerted action to eliminate their input to the Great Lakes. They are called "Level 1 substances". Dioxins/furans are one of the classes of Level 1 substances and are the subject of this report, which is in response to the U.S. challenge goal for dioxins and furans written in the GLBTS:

> U.S. Challenge: Seek by 2006, a 75 percent reduction in total releases of dioxins and furans (2,3,7,8-TCDD toxicity equivalents) from sources resulting from human activity. This challenge will apply to the aggregate of releases to the air nationwide and of releases to the water within the Great Lakes Basin, using the September 1994 draft dioxin Reassessment as an interim baseline. Once U.S. EPA has completed and released its final dioxin Reassessment, the Reassessment's 1987 emissions inventory will be used as the challenge baseline.

To guide Environment Canada (EC) and the United States Environmental Protection Agency (EPA), along with their partners, as they work toward virtual elimination of the strategy substances, the GLBTS outlined a four-step analytical framework:

1. Gather Information

2. Analyze current regulations, initiatives, and programs which manage or control substances

3. Identify cost-effective options to achieve further reductions

4. Implement actions to work toward the goal of virtual elimination.

This report documents the analyses associated with Steps 1 and 2 of the four-step process for dioxins/furans in the United States. Step 1 encompasses identifying all sources, both within and outside the Great Lakes Basin, by economic sector, that contribute to loadings in the Basin. Step 1 also requires consideration of how the substance is used or released, its lifecycle, multi-media loadings, and associated impacts. Step 2 involves assessing existing regulations and programs and how they influence the presence of dioxins/furans in the Great Lakes Basin and long-range transport from other areas into the Basin. Both Steps 1 and 2 involve identifying gaps: information gaps as to sources, loadings, and impacts, and regulatory or program gaps where there is opportunity to achieve greater reductions in substance releases.

Section 2 of this report discusses dioxins and furans in the environment, their environmental impacts, and effects on human health. Section 3 describes the sources of

dioxins/furans, both nationwide and in the Great Lakes states. Regulations controlling sources of dioxins/furans are outlined in Section 4, and non-regulatory programs aimed at reducing dioxin/furan releases are described in Section 5. Discussion and conclusions are provided in Section 6.

2.0 ENVIRONMENTAL AND HEALTH CONCERNS

2.1 Description of Dioxins/Furans

Dioxins and furans are toxic chemical compounds which belong to the class called halogenated aromatic hydrocarbons. Dioxins and furans are similar in chemical structure as shown in Figure 1 and have similar chemical and physical properties. Toxicity is best understood with chlorinated dioxins and furans, although brominated compounds and combined bromo-chloro compounds are also under study. Chlorinated dioxins and furans are technically referred to as polychlorinated dibenzo-para-dioxins and polychlorinated dibenzofurans, but for the purposes of this report will be referred to simply as "dioxins" and "furans". Dioxins and furans are not intentionally produced, but are generated as by-products of various combustion and chemical processes. They are colorless crystal or solids with high melting points, very low water solubility, high fat solubility, and low volatility. Dioxins and furans are extremely stable under most environmental conditions making them persistent once released in the environment. Because they are lipophilic, they also tend to bioaccumulate.

There are 75 individual chlorinated dioxins and 135 individual chlorinated furans. Each individual dioxin and furan is referred to as a congener. The properties of each congener vary according to the number of chlorine atoms present and the position where the chlorines are attached. Only congeners with chlorines attached at a minimum in the 2,3,7, and 8 positions exhibit the high toxicity historically associated with dioxin. There are a total of seven dioxin and ten furan congeners which contain chlorines in the 2,3,7,8-position and of these, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the best understood and serves as the marker compound for this class. For risk assessment purposes, estimates of the toxicity of sources which contain a mixture of dioxin and furan congeners are often expressed as toxicity equivalents (TEQ). TEQ is calculated by multiplying concentrations of each dioxin and furan congener present in a source with a toxicity equivalency factor (TEF). The TEF is an estimate of each congener's toxicity relative to the toxicity of 2,3,7,8-TCDD. The TEQ values for each congener are added together for the total TEQ concentration. Thus, concentrations of dioxins and furans represented as a TEQ concentration provide a quantitative estimate of toxicity as if all congeners present in the mixture are a toxic equivalent mass of 2,3,7,8-TCDD.

In addition to dioxin and furan congeners, coplanar polychlorinated biphenyls (PCBs), a subset of PCBs, also exhibit dioxin-like toxicity due to their structural and conformational similarities to dioxin compounds. Coplanar PCBs are routinely included in the calculation of dioxin/furan TEQs in toxicity assessments. Only 13 of the total 209 PCB congeners are thought to have dioxin-like toxicity; these are PCBs with four or more chlorines with just one or no

substitution in the ortho position, and which assume a flat configuration with rings in the same plane.

2.2 Environmental Impacts and Loadings

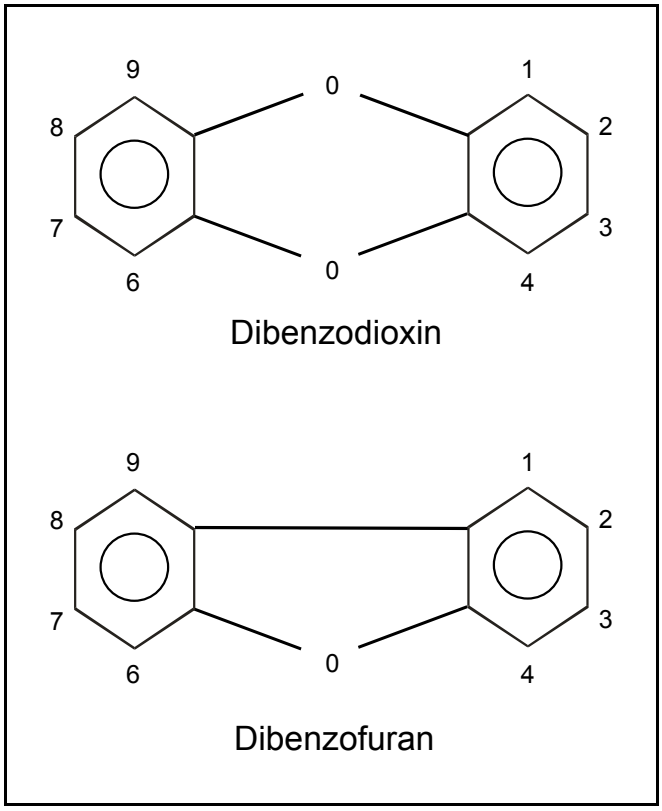

Figure 1. Structure of Dioxins and Furans

Dioxins and furans enter the environment primarily by releases to the air which are subject to long range transport and atmospheric deposition, by releases directly to land, by releases to water, and by occurrence in commercial products. Emissions to air are perhaps the best characterized of all the releases to the environment. Studies of sediment corings have been very useful in tracing the pattern of dioxin and furan emissions over time and have shown that concentrations were low but steady from 1860 to 1930, increased rapidly from 1930 to the mid-1960s marking a time-span of increased industrial activity, and have decreased since then likely due to the advent of pollution control measures (USEPA, 1994a). Once released to the environment, dioxins and furans generally become associated with particulates and organic matter due to their low solubility in water and high lipophilicity. Soils and sediments are considered the "ultimate sink" for dioxins and furans due to the compounds' affinity for particulate organic matter and extremely slow degradation. Dioxins in sediments accumulate in aquatic animals and proceed to bioaccumulate from there throughout the food chain. Dioxins also enter the food chain through deposition onto plants which are then consumed by animals or humans.

A recent study using sediment core methodology and homolog composition analysis to estimate relative atmospheric contribution of dioxins and furans found that atmospheric deposition currently accounts for 100 percent of both dioxins and furans to Lake Superior. The atmosphere was also estimated to be the largest source of dioxins to Lake Michigan, accounting for 100% of the dioxins in southern Lake Michigan and 33-50% of the dioxins in northern Lake Michigan. However, atmospheric deposition was estimated to account for only 5-35% of the furans in Lake Michigan and very little of either dioxins (5-35%) or furans (<5%) in Lake Ontario, suggesting likely non-atmospheric sources (Pearson et al., 1998).

In 1998, dioxins and furans were responsible for the issuance of 59 fish consumption advisories by 19 states, down from a high of 65 advisories in 1997. Of the 59 advisories, 17 are within states bordering the Great Lakes. These advisories included: two in Wisconsin (both for inland rivers), seven in Michigan (four in inland rivers, three in Lake Huron), and eight in New York (one marine coastal, two in inland rivers, two in Great Lakes connecting waterbodies (St. Lawrence and Niagra Rivers), and three in Lake Ontario (including all tributaries)). Although there are no statewide advisories in effect for dioxin/furans in freshwater lakes and/or rivers, the state of New York does have a statewide advisory for dioxin/furans in effect for its coastal marine waters (USEPA, 1999a).

2.3 Exposure and Health Effects

Exposure and health effects of dioxins and furans have been summarized in detail in the three volume 1994 health assessment document generated by the U.S. EPA for dioxins and related compounds (USEPA, 1994b). Information included in this section is largely taken from that health assessment document.

Much of the information regarding exposure and health effects of dioxin and furans comes from animal studies where the dioxins and furans have been introduced to the animals orally. Such exposure has produced a number of toxic responses including reproductive and developmental effects, severe loss of weight, immunological and neurological effects, skin disorders, cancer, and death. Although studies have shown a wide range of sensitivities among species before toxic effects appear, the effects can generally be produced if a proper dose is chosen. The observation of adverse health effects in humans has been limited to exposed populations following industrial accidents or inadvertent exposure to contamination. The most common human health effect observed as a result of exposure is development of chloracne, a severe and prolonged acne-like skin disease. Dioxins are also classified by EPA as group B2 probable human carcinogens, on the basis of inadequate human data and sufficient evidence of carcinogenicity in animals (USEPA, 1999a).

Exposure to dioxins and furans can occur through ingestion, dermal contact, and inhalation. The primary route of human exposure is thought to be through the diet with meat, dairy products, fish, and seafoods being the largest dietary sources. Once dioxins and furans are absorbed into the blood, they are distributed primarily to the liver and fat tissue. The rate of absorption and the distribution of dioxins and furans to tissues varies among the congeners, the route of exposure, the dose, and the age of the subject. Based on a single human test, 87% of the 2,3,7,8-TCDD ingested in a corn oil base was absorbed in the gastrointestinal tract (Poiger and Schlatter, 1986). Animal studies have shown similar absorption of 2,3,7,8-TCDD. Animal studies of other congeners show that congeners with fewer chlorines have increased absorption compared to congeners with greater numbers of chlorines. Once ingested, dioxins and furans persist in the body, allowing them to accumulate over time. Half-lives of dioxins and furans in humans have been measured ranging from approximately one to ten years. The accepted half-life for 2,3,7,8-TCDD, which is generally used as a representative value for most environmental dioxin/furan mixtures, as well as for risk assessment purposes, is seven years.

2.4 Sensitive Subpopulations and Geographic Regions

Dioxin and furan analysis of human tissue samples collected in 1987 for the National Human Adipose Tissue Survey (NHATS) showed that dioxin and furan concentrations in the tissues were fairly uniform geographically and showed no significant difference on the basis of race or sex. However, various subpopulations may have higher than average exposure to dioxins and furans for a variety of reasons including occupational exposure, industrial accidents, proximity to sources, and dietary habits.

Dietary intake is the most important route of exposure to dioxins and furans for the general population. Because the commercial food supply in the U.S. comes from multiple locations and is nationally distributed, most of the population receives similar levels of dioxin/ furan exposure due to typical food consumption. In effect, the highly distributed nature of the food supply tends to minimize the risk of higher than average exposure from a single contaminated product. However, certain populations, such as recreational and subsistence fishers, hunters, and farmers may be at greater risk if they obtain their food from a single location and if that location is contaminated above background levels. Additionally, some individuals and groups may consume above average quantities of animal fats or other foods known to have relatively high dioxin and furan concentrations (i.e., meat, dairy products, fish, and seafoods), often because these food sources are readily available or due to cultural tradition. Populations having fat consumption rates above the mean are at a greater risk of dioxin exposure; for example, it is estimated that those in the 95th percentile of fat consumption, which represents a consumption rate double that of the mean, would also double their background exposure to dioxins/furans (Winters, personal communication, 2000). Additionally, nursing infants may also be at risk of higher than average dietary exposure to dioxins and furans as a result of the transfer of dioxins and furans from the mother to the infant by way of breast milk.

3.0 SOURCES OF DIOXINS/FURANS

In April, 1998 the U.S. EPA issued a draft release of *The Inventory of Sources of Dioxin in the United States* (USEPA, 1998). This '98 Inventory is an update of the inventory of emission sources first presented in the EPA 1994 Reassessment document, *Estimating Exposure to Dioxin-Like Compounds* (USEPA, 1994a), and is the most recent and most comprehensive U.S. source of dioxins, furans, and dioxin-like PCBs available. The '98 Inventory gives emission estimates for two reference years (1987 and 1995) which allows easier monitoring of trends in emissions. The 1987 and 1995 data from the '98 Inventory are listed in Table 1 below and clearly show a downward trend in overall emissions from 1987 to 1995. Once this inventory is finalized by EPA, the 1987 emission estimates for anthropogenic sources will become the baseline emission level from which the U.S. GLBTS challenge goal of 75% reduction in emissions by 2006 will be evaluated. It should be noted that some estimates in Table 1 below will change when the Final Inventory is released as a result of additional data available since April, 1998. In particular, data collected as facilities exhibit compliance with new maximum achievable control technology (MACT) standards will significantly reduce uncertainty in

emissions for certain source sectors such as medical waste incineration. Expected changes are discussed in the text descriptions of individual sources but are not reflected in Table 1, as revised quantitative estimates had not been released at the time of this report.

For most source categories, the national emission values are estimates because only a few facilities were actually tested for dioxins and furans. National emission estimates were made by using the available testing data to generate emission factors representative of the source category and multiplying that factor by an activity level representative of the source nationwide (e.g., the emission factor for hazardous waste incinerators was determined to be 3.8 ng TEQ/kg waste combusted; this was then multiplied by the total kg of hazardous waste combusted annually in the United States (1.5×10^9 kg/yr for reference year 1995) to generate the national emission estimate for hazardous waste incinerators (5.7 g TEQ/yr for reference year 1995). Because the uncertainty about the emission estimates varies for each source based on the quality of the emission factor developed and/or the accuracy of the activity level, the '98 Inventory assigns a confidence rating to both the emission factor and the activity level, and then to the overall emission estimate. Following is a general description of the criteria for each confidence rating:

Confidence Rating	Activity Level Estimate	Emission Factor Estimate
High	Derived from comprehensive survey	Derived from comprehensive survey
Medium	Based on estimates of average plant activity level and number of plants or limited survey	Derived from testing at a limited but reasonable number of facilities believed to be representative of source category
Low	Based on expert judgment or unpublished estimates	Derived from testing at only a few, possibly non-representative facilities or from similar source categories or foreign surveys where differences in industry practices may be likely

The overall confidence rating assigned to an emission estimate for a source category is the lower of the two confidence ratings from the corresponding activity level and emission factor. Based on the confidence rating obtained, a range of emission values is listed for each source category. The central value represents what is believed to be the best estimate; however, the lower and upper ranges give a sense of the uncertainty in the central value and an idea of the range in which the true value might fall. If a source is given a low confidence rating, the range about the central value is constructed so that the upper end of the range is ten times higher than the lower end. For a medium confidence rating, the upper end is five times higher than the lower end, and for the high confidence rating, the upper end of the range is two times higher than the lower end. It should be noted that this method for assigning a range of values was of concern to the Draft Inventory peer review and will probably not be retained in the Final Inventory. While Table 1 contains only the central value estimate for each source category, Table 2 in Section 3.6 below

provides the estimated upper and lower limits of the potential range of emissions to air for each source category.

Table 1. Sources of Dioxins, Furans, and Dioxin-Like PCBs in the U.S. for Reference Years 1987 and 1995 [a]

Emission Source	Emissions (g TEQ/yr) to Media for Reference Year 1987				Emissions (g TEQ/yr) to Media for Reference Year 1995			
	Air	Water	Land	Product	Air	Water	Land	Product
Waste Incineration								
Municipal waste incineration	7,915	*	*	NA	1,100	*	*	NA
Hazardous waste incineration	5.0	*	*	NA	5.7	*	*	NA
Boilers/industrial furnaces	0.77	*	*	NA	0.38	*	*	NA
Medical waste/pathological incineration	2,470	*	*	NA	477	*	*	NA
Crematoria	0.16	*	*	NA	0.24	*	*	NA
Sewage sludge incineration	6.0	*	*	NA	6	*	*	NA
Tire combustion	NEG	*	*	NA	NEG	*	*	NA
Pulp and paper mill sludge incineration	(b)	*	*	NA	(b)	*	*	NA
BioGas combustion	**	NA	NA	NA	**[0.1]	NA	NA	NA
Power/Energy Generation								
Vehicle fuel combustion (leaded)	32.4	NA	NA	NA	NEG	NA	NA	NA
-unleaded	3.8	NA	NA	NA	6.3	NA	NA	NA
-diesel	26.3	NA	NA	NA	33.5	NA	NA	NA
Wood combustion (residential)	89.6	NA	*	NA	62.8	NA	*	NA
-industrial	27.5	*	*	NA	29.1	*	*	NA
Coal combustion (residential)	**	NA	*	NA	**[10]	NA	*	NA
-industrial/utility	62.6	*	*	NA	72.8	*	*	NA
Oil combustion (residential)	**	NA	NA	NA	**[10]	NA	NA	NA
-industrial/utility	15.5	*	NA	NA	9.3	*	NA	NA
Other High Temperature Sources								
Cement kilns (haz. Waste burning)	117	*	*	*	153	*	*	*
Cement kilns (non haz. waste burning)	13.7	*	*	*	17.8	*	*	*
Asphalt mixing plants	**	*	*	*	**[10]	*	*	*
Petro. Refining catalyst regeneration	*	NEG	*	NA	*	NEG	*	NA
Cigarette combustion	1.0	NA	*	NA	0.81	NA	NA	NA
Carbon reactivation furnaces	NEG	NA	NA	NA	NEG	NA	NA	NA
Kraft recovery boilers	2.0	*	*	NA	2.3	*	*	NA
Minimally Controlled or Uncontrolled Combustion								
Combustion of landfill gas in flares	**	NA	NA	NA	**[10]	NA	NA	NA
Landfill fires	**	NA	*	NA	**[1000]	NA	*	NA
Accidental fires (structural)	*	*	*	NA	*	*	*	NA
Accidental fires (vehicles)	**	*	*	NA	**[10]	*	*	NA
Forest, brush, and straw fires	170	NA	*	NA	208	NA	*	NA
Backyard trash burning	**	NA	*	NA	**[1000]	NA	*	NA
Uncontrolled combustion of PCBs	*	*	*	NA	*	*	*	NA
Metallurgical Processes								
Ferrous metal smelting/refining								
-Sintering plants	**	*	*	NA	**[100]	*	*	NA
-Coke production	**	*	*	NA	**[10]	*	*	NA
-Electric arc furnaces	**	*	*	NA	**[10]	*	*	NA
-Ferrous foundries	**	*	*	NA	**[10]	*	*	NA

Table 1. Sources of Dioxins, Furans, and Dioxin-Like PCBs in the U.S. for Reference Years 1987 and 1995 [a] (Continued)

Emission Source	Emissions (g TEQ/yr) to Media for Reference Year 1987				Emissions (g TEQ/yr) to Media for Reference Year 1995			
	Air	Water	Land	Product	Air	Water	Land	Product
Nonferrous metal smelting/refining -Secondary aluminum smelting	9.5	*	*	NA	17	*	*	NA
-Secondary copper smelting	304	*	*	NA	541	*	*	NA
-Secondary lead smelting	1.22	*	*	NA	1.63	*	*	NA
Scrap electric wire recovery	*	*	*	NA	*	*	*	NA
Drum and barrel reclamation	NEG	NEG	NEG	NA	NEG	NEG	NEG	NA
Chemical Manuf./Processing Sources								
Bleached chemical wood pulp and paper mills	*	356	14.1	505	*	19.5	1.4	24.1
Mono – to tetrachlorophenols	NEG	NEG	NEG	NEG	NEG	NEG	NEG	NEG
Pentachlorophenols	NEG	NEG	NEG	36,000	NEG	NEG	NEG	25,000
Chlorobenzenes	NEG	NEG	NEG	NEG	NEG	NEG	NEG	NEG
Chlorobiphenyls (leaks/spills)	NEG	NEG	NEG	NA	NEG	NEG	NEG	NA
Ethylene dichloride/vinyl chloride	*	*	NEG	*	*	*	NEG	*
Dioxazine dyes and pigments	NEG	NEG	NEG	64	NEG	NEG	NEG	0.36
2,4-Dichlorophenoxy acetic acid	NEG	NEG	NEG	21.3	NEG	NEG	NEG	18.4
Non-incinerated municipal sludge	NA	NA	207	7.0	NA	NA	207	7
Tall oil-based liquid soaps	NEG	NEG	NEG	*	NEG	NEG	NEG	*
Biological Formation	NA	*	*	NA	NA	*	*	NA
Photochemical formation	*	*	*	NA	*	*	*	NA
Reservoir Sources								
Emissions from chlorophenol-treated wood	*	*	*	NA	*	*	*	NA
Total	**11,274**	**356**	**221**	**36,597**	**2,745**	**20**	**208**	**25,050**

(a) At the time this report was being prepared, the Final Dioxin Inventory, which will have revised emission estimates for some source categories, was not available. Therefore, the values reported in this table reflect the estimates in the 1998 peer reviewed Draft Dioxin Inventory.

(b) Included within total for Wood Combustion – Industrial

* Some evidence exists suggesting that this category is a source of CDD/CDF emissions. However, insufficient data are available for making a quantitative emission estimate.

** Evidence exists suggesting that this category is a source of CDD/CDF emissions. Preliminary estimates of emissions for reference year 1995 have been made, but the confidence in the emission factor estimates and/or activity level estimates are so low that the estimates are too uncertain to include in the inventory. A number in square brackets indicates the order of magnitude estimate for this source; however, this number is not included in the calculation of emission totals.

NA = Not applicable.

NEG = Expected to be negligible (i.e., less than 1 gram per year) or non-existent

3.1 Air Emissions

Of the total estimated emissions to air, five source categories are estimated to account for 90% of the emissions. These five sources include municipal solid waste incineration, medical waste incineration, cement kilns burning hazardous waste, forest fires, and secondary copper smelting, although cement kilns and secondary copper smelting are expected by EPA to assume less significance in the Final Inventory. Each of these five sources is discussed briefly below.

Municipal Solid Waste Incineration. Many factors can affect emissions generated in this source category: furnace design, composition of the waste feed, temperature in the post-combustion zone, and the type of anti-pollution control device. To achieve a representative emission estimate, this source was broken into subcategories based on those differentiating factors, with each subcategory having its own emission factor. The emission factors were given a confidence rating of "medium" based on 10% of the facilities actually being tested for the 1987 reference year, and 21% of the facilities being tested for the 1995 reference year. The activity levels used to generate the estimate had a "high" confidence level as there was historical information for almost all facilities for both the 1987 and 1995 reference years. Overall the category was given a "medium" confidence rating. As a result, the range about the central estimate value varies by a factor of five. For 1987, the central estimate of annual emissions is 7,915 g TEQ/year with a range of 3,540 - 17,698 g TEQ/year. For 1995, the central estimate is 1,100 g TEQ/year with a range of 492 - 2,460 g TEQ/year. Emissions standards and guidelines have been promulgated for new and existing large (>250 tons/day) Municipal Waste Combustion (MWC) facilities, and proposed for Small MWC Facilities (35 - 250 tons/day). EPA estimates that when full compliance with the MWC rules (as applied to all new and existing waste-to-energy plants and incinerators with the capacity to burn more than 35 tons of garbage per day) is reached that the annual emissions resulting from municipal solid waste incinerators will decline significantly to about 24 g TEQ/year (USEPA, 1998).

Medical Waste Incineration. This source category consists of the controlled burning of solid waste by hospitals, veterinary facilities, and medical research facilities. Medical waste incineration is not very well characterized as to the number of facilities, types of anti-pollution control devices used, or the volume of waste combusted in any given year. Permits were not required for this type of incineration until the early 1990s. Between 1987 and 1995 the total number of medical waste incinerators operating and the amount of waste incinerated dropped significantly due to increasing regulations and less expensive alternatives for the treatment of waste. Emissions from only one percent of medical waste incinerators have actually been tested. Both the emission factor and the activity level for this source category received "low" confidence values leading to an overall "low" confidence rating for this source category. As a result, the range about the central estimate for this category varies by a factor of ten. For 1987, the central estimate of annual emissions is 2,470 g TEQ/year with a range from 781 - 7,810 g TEQ/year. For 1995, the central estimate is 477 g TEQ/ year with a range from 151 - 1,510 g TEQ/year. EPA expects full compliance with MACT Emission Guidelines and New Source Performance Standards (NSPS) for hospital, medical, and infectious waste incinerators to result in a decline of nationwide emissions from this source to about 6-7 g TEQ/year (Winters, personal

communication, 2000). In addition, as a result of MACT testing requirements, actual emissions data will eventually be available for all facilities in this sector, and therefore there will no longer be a need to estimate emissions based on a common emission factor for multiple facilities.

Cement Kilns Burning Hazardous Waste. Hazardous wastes such as waste oil, spent organic solvents, sludges from the paint and coatings industry, waste paint and coatings from auto and truck plants, and sludge from petroleum refineries are used as supplementary fuels by some cement kilns. Of the 34 facilities which burn hazardous waste, 12 have been tested during trial burns. Trial burns are suspected of causing greater dioxin and furan emissions than would occur during normal operations and, therefore, the emission factor for this category which was developed from the trial burn data was given a "low" confidence rating. The activity level for this source achieved a "high" confidence rating. Overall the source estimates for hazardous waste burning cement kilns were given a "low" confidence value resulting in the range about the central estimate varying by a factor of ten. The 1987 central estimate is 117 g TEQ/year with a range from 37.0 - 370 g TEQ/year. The 1995 central estimate is 153 g TEQ/year with a range from 48.4 - 484 g TEQ/year. Since the '98 inventory estimates were made, significant changes have occurred in emissions control technology (i.e., most facilities now use quenching to control inlet temperatures) under the Hazardous Waste Combustor MACT, and it is believed that emissions from cement kilns are probably much lower now than are reflected in the '98 inventory. EPA is currently working on revising estimates for the Final Inventory.

Forest, Brush, and Straw Fires. Data to develop an emission factor for this category were essentially non-existent; therefore, the best estimate for an emission factor was to use the factor developed for residential wood burning. This factor was given a "low" confidence rating. The activity level received a "medium" confidence rating as good data were available for the number of acres burned, but less certain information existed regarding the biomass burned per acre. Overall this source category achieved a "low" confidence rating and the range about the central estimate varies by a factor of ten. The 1987 central estimate is 170 g TEQ/year with a range from 53.8 - 538 g TEQ/year. The 1995 central estimate is 208 g TEQ/year with a range from 64.5 - 645 g TEQ/year.

Secondary Copper Smelting. Secondary copper smelters recover copper and precious metals from copper and iron-bearing scrap. A single facility was tested in 1987. This single facility was deemed to be representative of the process technology and anti-pollution control devices typical of the source category. Because only a single facility was tested, the emission factor for this category received a "low" confidence rating. The activity level for this category has a "high" confidence rating. Overall this category received a "low" confidence rating resulting in a factor of ten range about the central estimate value. The central estimate for 1987 is 304 g TEQ/year with a range from 96 - 960 g TEQ/year. The central estimate for 1995 is 541 g TEQ/year with a range from 171 - 1,710 g TEQ/year. However, based on information submitted regarding this source category in the peer review of the '98 Inventory, combined with the closing of many facilities that had high dioxin emission levels, secondary copper smelting is expected to have revised, and significantly lower, emissions estimates in the Final Inventory.

EPA is currently collecting additional data to revise these emissions values in the Final Inventory.

Other Sources. Of the remaining sources to air, the combination of diesel fuel combustion, residential wood combustion, and industrial wood combustion generate another approximately five percent of the total dioxin and furan emissions. All other sources make up the remaining five percent of total emissions, with each of these sources emitting fewer than 20 g TEQ/yr.

Additionally, there are several new and potentially large sources of dioxins and furans to air listed in the '98 Inventory. These sources are recognized as "preliminary order of magnitude" estimates because either the confidence in emission factor estimates and/or activity level estimates were considered too uncertain to include in the inventory. The preliminary order of magnitude estimates are not included in the emission totals, but it should be noted that, in particular, backyard trash burning and landfill fires, with estimated emissions of 1000 g TEQ/yr each, could potentially be two of the largest sources of emissions to air. A recent study on the open burning of household waste in barrels estimated that two to forty households burning their trash daily in barrels can produce average dioxin and furan emissions comparable to a modern, clean operating municipal solid waste incinerator with good combustion and fuel gas cleaning technology, burning 200 tons/day (Lemieux et al., 2000). Although the extent of open trash burning in the Great Lakes region is not known, the practice may be more prevalent in rural areas and tribal communities where trash collection and recycling opportunities may not be as readily available as in urban areas.

3.2 Water Releases

In the '98 Inventory, the only estimated releases of dioxins and furans to water were those attributed to bleached chemical wood pulp and paper mills. Pulp and paper mill emission estimates received an overall "high" confidence rating due to high confidence in both the emission factor, which was developed based on direct measurements at virtually all facilities, and high confidence in the activity level. Based on this rating, the range of emissions for this source varies by a factor of two. For 1987, the central estimate is 356 g TEQ/yr with a range from 252 - 504 g TEQ/yr. For 1995, the central estimate is 19.5 g TEQ/yr with a range from 13.8 - 27.6 g TEQ/yr. The large reduction in emissions from 1987 to 1995 is due to the pulp and paper industry changing processes used in the production of chemically bleached wood pulp to reduce the formation of dioxins and furans, in response to specific regulatory requirements under the Pulp, Paper and Paperboard "Cluster Rule" (63FR 18504).

While good estimates for point sources to water are available for pulp and paper related releases, there was insufficient information available at the time of the development of the '98 Inventory to generate estimates for Publicly Owned Treatment Works (POTW), urban runoff, and potential industrial or commercial sources. Data to characterize water releases from these possible sources is still lacking.

In addition, releases of dioxin to water from soil erosion were not estimated for the '98 Inventory. In the Final Inventory, quantitative estimates for this reservoir to water will be provided. Given the high background concentrations of dioxins and furans in soils in the U.S., soil erosion is expected by EPA to be a significant source of dioxins/furans to water in the Final Inventory.

3.3 Releases to Land

Sources of dioxin and furan releases to land listed in the '98 Inventory include a small percentage of sludge generated by pulp and paper manufacturing that is not landfilled or incinerated, as well as non-incinerated municipal sludge. The total releases from land-applied, non-incinerated municipal sludge of 207 g TEQ/yr include 105.5 g TEQ/yr from dioxins and furans and 101.3 g TEQ/yr from dioxin-like PCBs. The information regarding dioxins and furans received high confidence values for both activity level and emission factor estimates resulting in an overall "high" confidence value. As a result the range between the upper and lower estimate varies by a factor of two (central value of 105.5 g TEQ/yr, range of 74.6 - 149 g TEQ/yr).

Any sources disposed in permitted landfills were not included in the '98 Inventory based on the assumption that properly designed and operated landfills prevent dioxins and furans from being recirculated in the environment. Although the '98 Inventory does not include disposals to permitted landfills in its emission estimates, it does provide information on several dioxin and furan sources which are known to be landfilled. Municipal solid waste incinerator ash, which is required to be disposed of in permitted municipal solid waste landfills, was estimated to be responsible for 1,800 g TEQ/yr landfilled in 1995 and 1,300 g TEQ/yr landfilled in 1987. It was also estimated for both 1995 and 1987 that approximately 99 g TEQ/yr result from properly landfilled sewage sludge. Other possible sources which may be landfilled include pulp and paper mill wastewater sludge, dredge spoils, and incinerator ash from other than municipal solid waste incinerators. In addition, the '98 Inventory does not estimate releases from deficient landfills. In the Great Lakes Basin at least one landfill contaminated with dioxin (Hyde Park landfill, Niagara, New York) has been implicated as a possible significant source of dioxin loading to Lake Ontario (Cohen et al., 1997).

3.4 Releases to Products

Only a limited number of products have actually been tested for dioxins and furans. In the '98 Inventory, pentachlorophenol (PCP), which is used primarily as a wood preservative, is the predominant source accounting for over 99% of the dioxins and furans in products. Both the emission factor and activity level for PCP received a "high" confidence rating resulting in an overall "high" confidence rating for the emissions estimate for this source. Based on this confidence level, the range of potential contamination in PCP treated wood products varies by a factor of two and ranges from 25,500 - 51,000 g TEQ/yr for 1987 and from 17,700 - 35,400 g TEQ/yr for 1995.

3.5 Non-point and Reservoir Sources

Emissions to air from sources outside of the United States and their subsequent long range transport and atmospheric deposition within the United States were not included in the '98 Inventory.

Reservoir sources such as sediments, soils, plants, and PCP-treated wood which contain previously formed dioxins and furans that have the potential to recirculate in the environment were also not included in the '98 Inventory. However, as discussed in section 3.2, quantitative estimates of soil erosion releases to water will be provided in the Final Inventory. It is known that water concentrations of dioxins/furans are affected by sediment concentrations, which in turn are affected by dioxin/furan concentrations in soil.

Although EPA does not currently have good quantitative information on the overall relationship between reservoir and contemporary sources, recent research suggests that reservoir sources are likely to be an important contributor to dioxin/furan levels in the environment, with sediments serving as a primary reservoir source. For example, research indicates that significant amounts of dioxins and furans in fish are from reservoir sources, further supporting the conclusion that general background levels of dioxins and furans due to contemporary releases do not entirely account for dioxin/furan levels of concern in the environment today (Winters, personal communication, 2000).

3.6 Comparison of the '98 Inventory to Other Source Inventories

The primary concern with deriving data by estimations as in the '98 Inventory is the degree of uncertainty associated with the estimations. The uncertainty in the estimates results primarily from the following:

1. Limited data availability to define emission classes, ascribe activity levels, develop emissions factors, and identify and classify sources

2. Changes over time in emission factors, activity levels, and facility classifications.

Examples of limitations or uncertainties associated with the estimates in the '98 Inventory include many estimates that are not completely inclusive of all sources. For example, vehicle emissions do not include any off-road vehicle uses such as construction vehicles or farm equipment and as mentioned above, water releases only list values for pulp and paper sources. In several studies (auto emissions for example), limited data are available on U.S. emissions and estimates were taken solely from studies done in other countries, which may or may not be representative of U.S. materials or practices. A number of sources (several of which are potentially large) are "preliminary order of magnitude estimates," which require additional supporting data to confirm the magnitude of the source. In addition to the inherent uncertainties in reporting emissions as estimates, the '98 Inventory does not include environmental releases

from potential reservoir sources (soils, sediments, PCP treated wood, and landfilled dioxin waste such as ash, etc.).

In spite of these limitations, until the Final Inventory is released, the ’98 Inventory is the most comprehensive inventory of sources currently available. Several recently published estimates of emissions to the atmosphere for the U.S. and Canada were reviewed and compared to emission levels reported in the ’98 Inventory. Three emission estimates for the U.S. and one from Canada have been summarized in Table 2 below.

Table 2. Comparison of Estimates of Dioxin Emissions to Air from Various Inventories

Emission Source	Estimates of Emissions to Air from Various Sources (g TEQ/yr)			
	U.S. ’95 Baseline - USEPA ’98 Inventory (1)	U.S. Estimate Commoner (2)	U.S. Estimate Thomas/ Spiro (3)	Draft ’97 Baseline Canada (4)
Waste Incineration				
Municipal waste incineration	492 - 2,460	1,000 - 5,000	900 - 9,000	152
Hazardous waste incineration	2.6 - 12.8	5 – 500	10 – 100	1.3
Boilers/industrial furnaces	0.12 - 1.2			
Medical waste/pathological incineration	151 - 1,510	100 - 2,000	200 - 20,000	2.5
Crematoria	0.07 - 0.75			
Sewage sludge incineration	2.7 - 13.4			
Tire combustion	NEG	10 – 100	10 – 100	0.1
Pulp and paper mill sludge incineration	(a)			
BioGas combustion	**[0.1]		0.1 – 3	
Power/Energy Generation				
Vehicle fuel combustion - leaded	NEG			
Vehicle fuel combustion - unleaded	2.0 – 20	}1 – 11	}30 – 300	0.1
Vehicle fuel combustion - diesel	10.6 – 106	50 – 500		8.7
Wood combustion - residential	19.8 – 198		20 – 500	17.9
Wood combustion - industrial	13 – 65	}70 - 700	30 – 1000	27.7
Coal combustion - residential	**[10]			4.6
Coal combustion - industrial/utility	32.6 – 163	}100 - 1000	}5 – 50	
Oil combustion - residential	**[10]			7.0
Oil combustion - industrial/utility	2.9 – 29	}5 - 60		
Other High Temperature Sources				
Cement kilns (haz. Waste burning)	48.4 – 484			24.4
Cement kilns (non haz. Waste burning)	5.6 - 56.3	}200 - 1000	}90 - 8,000	3.3
Asphalt mixing plants	**[10]	10 - 100		
Petro. Refining catalyst regeneration	*			
Cigarette combustion	0.25 - 2.5			
Carbon reactivation furnaces	NEG	0.07 - 0.7		1.4
Kraft recovery boilers	1.0 - 5.0	0.1 - 10	1 - 20	

Table 2. Comparison of Estimates of Dioxin Emissions to Air from Various Inventories (Continued)

Emission Source	Estimates of Emissions to Air from Various Sources (g TEQ/yr)			
	U.S. '95 Baseline - USEPA '98 Inventory (1)	U.S. Estimate Commoner (2)	U.S. Estimate Thomas/ Spiro (3)	Draft '97 Baseline Canada (4)
Minimally Controlled or Uncontrolled Combustion				
Combustion of landfill gas in flares	**[10]	2 - 20		
Landfill fires	**[1000]			
Accidental fires (structural)	*			
Accidental fires (vehicles)	**[10]	7 - 100		
Forest, brush, and straw fires	64.5 – 645	50 - 500	400 – 800	
Backyard trash burning	**[1000]			
Uncontrolled combustion of PCBs	*	*		
Metallurgical Processes				
Ferrous metal smelting/refining				
- Sintering plants	**[100]	80 - 1,000		42.9
- Coke production	**[10]	2 - 20		
- Electric arc furnaces	**[10]			10.2
- Ferrous foundries	**[10]	8 - 80		
Nonferrous metal smelting/refining				
- Secondary aluminum smelting	5.4 - 53.8	2 - 500		*
- Secondary copper smelting	171 - 1,710	100 - 800	80 – 900	
- Secondary lead smelting	0.73 - 3.65	1 - 70	0.8 – 5	0.1
Scrap electric wire recovery	*			
Drum and barrel reclamation	NEG	0.1 - 1	0.5 – 7	
Chemical Manufacturing/Processing Sources				
Bleached chemical wood pulp and paper mills	*			2.0
Mono- to tetrachlorophenols	NEG			
Pentachlorophenols	NEG	10 - 100		1.8
Chlorobenzenes	NEG			
Chlorobiphenyls (leaks/spills)	NEG			
Ethylene dichloride/vinyl chloride	*			
Dioxazine dyes and pigments	NEG			
2,4-Dichlorophenoxy acetic acid	NEG			
Non-incinerated municipal sludge	NA			
Tall oil-based liquid soaps	NEG			
Biological Formation	NA			
Photochemical formation	*			
Reservoir Sources				
Emissions from chlorophenol-treated wood	*			2.4
Total	**1,026 - 7,541**	**1,813 - 14,173**	**1,417 - 40,785**	**311**

(1) USEPA, 1998; (2) Cohen et al., 1997; (3) Thomas and Spiro, 1996; (4) EC, 1998

(a) Included within total for Wood Combustion - Industrial

* Some evidence exists suggesting that this category is a source of CDD/CDF emissions. However, insufficient data are available for making a quantitative emission estimate.

** Evidence exists suggesting that this category is a source of CDD/CDF emissions. Preliminary estimates of emissions for reference year 1995 have been made, but the confidence in the emission factor estimates and/or activity level estimates are so low that the estimates are too uncertain to include in the inventory. A number in square brackets indicates the order of magnitude estimate for this source; however, this number is not included in the calculation of emission totals.

NA = Not applicable.

NEG = Expected to be negligible (I.e., less than 1 gram per year) or non-existent

} Estimate is for the combined source category of where the } appears and the source category immediately above (e.g., for the U.S. estimate from Commoner, the vehicle fuel combustion estimate of 1-11 g TEQ/yr is for combined lead and unleaded fuel).

As can be seen in Table 2, the ’98 Inventory covers more potential emission sources than any of the other published emission estimates. The relative ranking of sources is similar among all emission estimates with regards to the magnitude of emissions. Across all estimates, incineration sources are considered to be the largest sources of dioxins and furans to air. In addition, the ’98 Inventory has identified two new potentially large emission sources, backyard trash burning and landfill fires. Among the three U.S. estimates, agreement on the lower end of the total annual emission range is much tighter than on the upper end (1,026 to 1,813 g TEQ/yr vs 7,541 to 40,785 g TEQ/yr). This may be in part because the ’98 Inventory baseline year of 1995 has incorporated in it some of the emission reductions that are beginning to be seen from the regulations in place on various types of waste incineration. The other estimates do not give a specific time frame reference and may include estimates from a time period before most waste incineration pollution control measures were in place. The difference in magnitude between U.S. and Canadian emissions can be largely attributed to differences in activity level between the two countries.

3.7 Relationship of Chlorine Content in the Feedstock and Dioxin Output for Combustion Sources

Although the ’98 Draft Inventory does not specifically address the relationship of chlorine content of feedstocks and dioxin output, recent research has been conducted regarding this issue.

The American Society of Mechanical Engineers (ASME) investigated the impact that waste feed chlorine content and waste stream components, including PVC plastics and salts, have on PCDD/F concentrations in the flue gases at waste combustion facilities (Rigo et al., 1996). Data were mostly obtained from full-scale tests, but also included some bench-scale laboratory studies. Laboratory-, bench-, and pilot-scale facility studies produced some discernible trends between PCDD/F gas side concentrations and chlorine feed rate; however, the authors concluded that although these types of tests are useful for mechanistic studies, they do not necessarily represent the performance of full-scale facilities. From their investigations of actual facilities, Rigo et al. concluded that there was no relationship between the amount of chlorine in the feed-stock and the dioxins in the stacks.

In contrast, some have challenged the ASME report and proposed that a higher degree of correlation exists between chlorine input and dioxin stack emissions than was concluded by Rigo et al. (1996). For example, Costner (1997) suggested that ASME used inappropriate and/or unreliable surrogate measures for chlorine inputs (e.g., normalized feed-rates and percent chlorine in feed) and dioxin outputs (e.g., HCl concentrations in stack gases) from combustors. Consequently, Costner concluded that the results of the statistical analyses conducted in the ASME report do not provide a valid basis for assessing the relationship between chlorine input and the amount of dioxin generated and released by full-scale waste combustors.

In other recent literature (published between 1995 and 1997), a variety of conclusions have been drawn regarding the issue of chlorine content of feedstocks and dioxin output. A good illustration of the variety of results found in the literature is also summarized in the Introduction

section of an article by Wikstrom, et al. (1996) which shows that the results of recent research can be broken down into three categories: finding a correlation between chlorine content in feedstocks and dioxin emissions (8 articles), not finding any correlation (5 articles), and finding a correlation only after the chlorine content has reached a threshold value of 1-2% (7 articles).

The review of these articles indicates the complexity of dioxin formation mechanisms during combustion and the difficulty in correlating results from bench-scale tests to full-scale facilities. EPA's Final Dioxin Reassessment is expected to address this issue.

4.0 REGULATIONS AFFECTING DIOXINS/FURANS REDUCTIONS

4.1 Overview of Federal and State Legislation

An overview of the major Federal environmental legislation in the U.S. which may affect loadings of dioxins and furans to the Great Lakes is presented in Table 3 below. Following the overview table, more detailed descriptions of each of the statutory authorities are provided.

Clean Air Act. The Clean Air Act (CAA) establishes requirements for airborne emissions of dioxin from a variety of sources. USEPA state, and regional air quality agencies are all likely to be involved in CAA implementation. The CAA also establishes the national ambient air quality standards which, although they have no direct regulatory impact, serve as a baseline for judging the effectiveness of air pollutant release regulations. Currently, there are no ambient air standards for dioxin.

Dioxins/Furans are included in the CAA Amendments (CAAA) Title III list of 189 Hazardous Air Pollutants (HAPs), and as required by the CAA, major sources of dioxins/furans have been identified in both the 1990 Emissions Inventory of Section 112(c)(6) Pollutants and the April 1998 *Inventory of Sources of Dioxin in the United States* (draft). Also as required by the CAAA, EPA is currently establishing and enforcing air emissions regulations, called National Emission Standards for Hazardous Air Pollutants (NESHAPs), for the major HAP source categories, including major sources of dioxins and furans as reported in the 1998 inventory. These standards are being developed by EPA under Sections 112 and 129 of the CAA (section 129 was added to the CAA specifically to address emissions from solid waste combustion) for both new and existing sources based on "maximum achievable control technology" (MACT), which is intended to reflect the maximum degree of reduction in emissions, taking into consideration the cost of achieving such emission reduction, and any non-air-quality health and environmental impacts and energy requirements that the Administrator determines are achievable for a particular category of sources. MACT rules define standards of performance for new stationary facilities, which may not be less stringent than the emissions control achieved in practice by the best controlled similar unit. These Section 112/129 new source performance standards (NSPS) are direct Federal regulations. MACT standards also establish emissions guidelines for existing facilities, which are implemented through State Implementation Plans and enforced by the State.

Table 3. Regulatory Overview of Dioxins and Furans in the U.S.

<table>
<tr><th colspan="6">Dioxin Regulatory Overview</th></tr>
<tr><th>CAA</th><th>CWA</th><th>SDWA</th><th>RCRA</th><th>SARA / EPCRA and CERCLA</th><th>FIFRA and TSCA</th></tr>
<tr><td>§112(c)(6): Major source categories identified;
MACT standards promulgated for MWC (40CFR 60), HMIWI (62 FR 48347), and HWC (64FR 52827)</td><td>CWA Priority: Listed priority pollutants (40CFR 423); subject to NPDES effluent limitations under §304(b) (40CFR 122) and general pretreatment (40CFR 403)

CWA Biosolids Rule: proposed standard of 300 parts per trillion toxic equivalents for dioxins in biosolids (64 FR 72045)</td><td rowspan="2">NPDWR / MCL: 30 pg/L (enforceable)

MCL goal for 2,3,7,8-TCDD is zero</td><td rowspan="2">RCRA: Several dioxin-bearing wastes are F-listed hazardous wastes, and as such are subject to land disposal restrictions (40CFR 261.31-32)

Land disposal restrictions for certain dioxin-containing and wood-preserving wastes (40CFR 268.30-31 Subpart C)

Universal treatment standards for dioxin levels in waste (40CFR 268.48)</td><td rowspan="2">CERCLA §103: Spills of 2,3,7,8-TCDD >1 lb. must be reported to the National Response Center

SARA §313: October 29,1999 Amendment adds dioxins and dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a threshold reporting quantity of 0.1 gram/year (64FR 58666)</td><td rowspan="2">FIFRA: Sale of Silvex and 2,4,5-T canceled for all uses (USEPA 1998); PCP use allowed only for wood on restricted basis (52FR 2282-2293)

TSCA §4: Dioxin / Furan Test Rule for certain commercial organic chemicals (52FR 21412-21452)</td></tr>
<tr><td colspan="2">Pulp and Paper Cluster Rule (63FR 18504): Sets new NESHAPS/MACT air standards specifically for the pulp and paper source category (under CAA 112(b)) and water effluent limitations and pretreatment standards for certain facility subcategories (under CWA 304(b), 307)</td></tr>
</table>

CAA: Clean Air Act
CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act
CWA: Clean Water Act
FIFRA: Federal Insecticide, Fungicide, Rodenticide Act
HAP: Hazardous Air Pollutant
HWC: Hazardous Waste Combustors
MACT: Maximum Achievable Control Technology
MCL: Maximum Contaminant Level. (Drinking water standard)
MWC: Municipal Waste Combustors
HMIWI: Hospital/Medical/Infectious Waste Incinerators
NESHAPS: National Emissions Standards for Hazardous Air Pollutants (HAPs)
NPDES: National Pollutant Discharge Elimination System
NPDWR: National Primary Drinking Water Regulations
RCRA: Resource Conservation and Recovery Act
SARA/EPCRA: Superfund Amendment Reauthorization Act / Emergency Planning and Community Right-to-know Act
SDWA: Safe Drinking Water Act
TRI: Toxic Release Inventory
TSCA: Toxic Substances Control Act

Federal air emissions standards have been finalized or proposed for several sectors that are important in terms of dioxin emissions, including: Municipal Waste Combustors (MWCs), Hospital/Medical/Infectious Waste Incinerators (HMIWIs), and Hazardous Waste Combustors (HWCs) (including hazardous waste-burning cement kilns). Air emissions standards have also been finalized for the pulp and paper industry, which has regulations promulgated under a special Pulp and Paper Cluster Rule, as discussed in Section 4.2. Implementation of MACT standards is expected to significantly reduce emissions from the major sources (i.e., municipal waste combustion, medical waste incineration, and hazardous waste-burning cement kilns) of dioxins and furans to air in the United States. For example, the emission standards and guidelines for municipal waste combustion are expected to reduce dioxins from these sources to about 24 g TEQ/year when full compliance with the MWC rules is reached (USEPA, 1998). Similarly, full compliance with standards for new and existing medical waste incinerators is expected to reduce dioxins from these source to about 6-7 g TEQ/year (Winters, 2000, personal communication). Emission standards have also been finalized for Hazardous Waste Combustors. The Agency's rules for MWC, HMIWI and HWC facilities will complement each other and, combined, are expected to provide significant overall reductions in dioxin emissions to air.

Clean Water Act. The Clean Water Act (CWA) regulates discharges of pollutants to the nation's surface waters, and may be implemented either by EPA or by State agencies.

Under the CWA, EPA is required to develop effluent guidelines for categories and classes of point sources. These guidelines are then used to set discharge limits for specific facilities that discharge pollutants directly to surface waters or indirectly via municipal sewage treatment systems. To implement discharge limits for direct dischargers, the CWA established the National Pollution Discharge Elimination System (NPDES) permit program, which defines the facility-specific conditions and effluent limitations under which a facility may make a direct discharge to surface water. The Clean Water Act prohibits any person from discharging a pollutant from a point source into navigable waters without a NPDES permit (33 U.S.C. sec. 1342, 40CFR 122). Some facilities are subject to dioxin effluent limits or monitoring requirements in their NPDES permits. Limits for water discharges are based on the use of Best Available Technology (BAT) economically achievable for specific point sources. Regulated facilities include the pulp and paper industry, which has regulations promulgated under a special Pulp and Paper Cluster Rule, as discussed in Section 4.2.

In addition to falling under federal requirements, water pollution is also regulated in every state based on state standards, which vary from state to state. States may require a separate discharge permit, which sometimes results in a dual system of permitting, whereby each facility must obtain both a federal NPDES permit and a state discharge permit. States can also gain EPA approval of state permitting systems so the states themselves can administer the NPDES program. In such cases, one permit issued by the state government meets both the federal and state requirements. States have the explicit right to enact any water quality standard or limitation that is more stringent than those required by federal statute (33 U.S.C. sec.1370).

Pollutant control requirements are established for indirect dischargers, i.e., industrial sources discharging to municipal sewer systems, in the National Pretreatment Program. Such indirect industrial dischargers must still comply with pretreatment standards to prevent pollutants from interfering with the POTW's operations (33 U.S.C. sec. 1317; 40CFR 403). There are both general pretreatment standards and pretreatment standards tailored to specific industrial categories. EPA requires that POTWs over 5 million gallons a day develop a local pretreatment program which may result in local permitting of all indirect dischargers.

Under section 303(d) of the CWA, EPA has established the Total Maximum Daily Loads (TMDLs) program to provide a framework for addressing both point and non-point sources of pollution. A TMDL establishes the maximum allowable pollutant loading for a waterbody, as based on that waterbody meeting standards set for water quality. TMDL determinations include assessment of point sources, non-point sources, and atmospheric inputs. Under the TMDL program, every two years States are required to identify and establish a priority ranking list of waterbodies that do not meet applicable water quality standards. Once the list is approved by EPA, States must establish a TMDL for each waterbody that specifies the pollution controls needed within a watershed. In addition, a TMDL must be "enforceable"; that is, there must be a plan for ensuring that actions are taken to reduce the pollutant to the safe level.

The CWA also requires EPA to develop and publish, and from time to time revise, the water quality criteria which reflect the relationship between pollutant concentrations and environmental and human health effects. These water quality criteria are not regulations, but are intended to guide States and Tribes in adopting water quality standards that provide a basis for controlling discharges of pollutants. There is currently an ambient water quality standard for protection of human health (consumption of water + organism) of 1.3×10^{-8} μg/L for dioxin (63 FR 68354).

The CWA regulates the use and disposal of municipal sewage sludge through the CWA Biosolids Rules. Although dioxin concentrations for the land application of sewage sludge are not currently limited under this rule, on December 23, 1999 EPA proposed a standard for dioxins in biosolids that would set a limit of 300 parts per trillion toxic equivalents for dioxins in biosolids that are to be recycled and applied to the land as fertilizer (64FR 72045). Facilities preparing biosolids for land application would also be required to follow new monitoring, record keeping, and reporting requirements for dioxins in biosolids that are to be land applied. Based on risk assessment results, the proposed rule does not contain additional limits for dioxins in biosolids that are being placed in surface disposal units or incinerated.

Safe Drinking Water Act. The Safe Drinking Water Act (SDWA) was established by Congress in 1974 to protect human health from contaminants in drinking water, and to prevent contamination of existing groundwater supplies. The SDWA National Primary Drinking Water Standards define enforceable maximum contaminant levels (MCLs), in addition to non-enforceable maximum contaminant level goals (MCLGs). The MCL is set as close to MCLG as possible, considering the ability of public water systems to detect and remove contaminants using

suitable treatment technologies. The MCLG for 2,3,7,8-TCDD under the SDWA is zero. Based on this MCLG, EPA has set a MCL of 30 parts-per-quadrillion (ppq or pg/L) for 2,3,7,8-TCDD.

Reporting Requirements and Spills. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund, was enacted to establish clean up requirements for uncontrolled, abandoned hazardous waste sites and to address future releases of hazardous substances into the environment. Releases of CERCLA-listed hazardous substances, if occurring in amounts exceeding a predefined "reportable quantity" (RQ), must immediately be reported to the National Response Center. CERCLA §103(a) requires that any spills or accidental releases of dioxin from any facility or other point source in quantities exceeding 1 lb. must be reported immediately (40CFR 302.4). There are also some dioxin reporting and testing requirements for specific industries, e.g., designated chemical manufacturers, under TSCA sections 4 and 8(e) (40CFR 766).

The Superfund Amendment and Reauthorization Act, known as SARA Title III, or the Emergency Planning and Community Right to Know Act (EPCRA), also requires notification and reporting of hazardous substances. The key regulatory requirements of EPCRA include emergency planning and release notification, Community Right-to-Know reporting, and Toxics Release Inventory (TRI) reporting.

Emergency planning may be required under EPCRA when substances on the Extremely Hazardous Substances list are present in quantities exceeding the Threshold Planning Quantities (TPQs). Dioxins/furans are not on the Extremely Hazardous Substances list.

In 1999 and previous years, dioxin releases to air, water, or land were not required to be reported in the Toxics Release Inventory (TRI) (SARA/EPCRA §313). In addition, electric utilities did not fall into the SIC code range covered by TRI and therefore were not required to report any TRI chemical releases. However, under an amendment to TRI published in the Federal Register as a final rule on October 29, 1999, dioxin and dioxin-like compounds (including 7 polychlorinated dibenzo-p-dioxins and 10 polychlorinated dibenzofurans) were added to the list of chemicals required to be reported, pursuant to its authority to add chemicals and chemical categories that meet the EPCRA section 313(d)(2) toxicity criteria. Under this amendment, releases of dioxins from qualifying facilities in excess of 0.1 grams per year are required to be reported to the TRI (64FR 58665). Also, under this rule utilities (e.g., SIC codes 4911, 4931, 4939) are among the potentially affected entities required to report dioxin releases. If affected facilities do not test their effluent, they are required to develop a reasonable estimate, based on available data, for reporting to TRI. The new rule becomes effective with the January 1, 2000 reporting year, and data collected under the new requirements will likely be available in 2002. The two most significant sources of dioxin and furans that will not be covered by TRI reporting requirements are municipal waste combustors and medical waste incinerators.

Waste Management Requirements under RCRA. The Resource Conservation and Recovery Act (RCRA) of 1976 establishes a regulatory structure for the handling, storage, treatment, and disposal of solid and hazardous wastes, which can fall under the regulatory

definition of "hazardous" either by falling under a category of listed hazardous wastes, or by exhibiting a characteristic of a hazardous waste.

The RCRA hazardous waste list includes wastes from non-specific sources (F-listed), wastes from specific sources (K-listed) and wastes comprised of discarded and off-specification chemical products (P- and U-listed). There are several dioxin-bearing wastes that are F-listed RCRA-hazardous wastes (40CFR 261.31). There are also several K-listed wastes from specific sources, including wastes from wood preserving operation, iron and steel production, and the copper industry, that may contain dioxin contamination (40CFR 261.32). Under RCRA, certain solids wastes are specifically exempt from being listed hazardous wastes, including household waste/garbage, waste from facilities that burn only household waste, and fly ash and bottom ash waste generated primarily from the combustion of coal or other fossil fuels (40CFR 261.4).

A waste that is not specifically listed as a hazardous waste can still be considered hazardous, however, if it exhibits a characteristic of a hazardous waste, including ignitability, corrosivity, reactivity, or toxicity. Under the toxicity characteristic test requirements (i.e., the Toxicity Characteristic Leaching Procedure (TCLP)), there are no specific requirements for testing or regulatory thresholds for dioxins or furans. There are regulatory thresholds for some substances that may contain dioxin as a contaminant, including pentachlorophenol and 2,4-D (40CFR 261.24). Hazardous wastes can be both listed and characteristic.

Any waste that is considered a RCRA hazardous waste (via a listing and/or a characteristic designation), is subject to land disposal restrictions (40CFR 268, Subpart C - Prohibitions on Land Disposal). Under the Land Disposal Restrictions, there are "Universal Treatment Standards" for hazardous constituent levels in waste, including wastewater. The Universal Treatment Standard levels for both dioxins and furans are 0.001 mg/kg for nonwastewater, and 0.000063 mg/L for wastewater (40CFR 268.48). If the waste is designated as hazardous and contains constituents in excess of the applicable Universal Treatment Standard levels then the waste is prohibited from land disposal. Specific dioxin-containing wastes that must comply with Land Disposal Restrictions include wastes from certain manufacturing processes (RCRA waste codes F020-F023, F026-F027), leachate and residues resulting from the incineration or thermal treatment of soil contaminated with certain EPA Hazardous Wastes, and certain wastes and untreated wastewater from the production of 2,4- D (RCRA waste codes K043 and K099).

Product Management Requirements under TSCA. Based on evidence that halogenated dioxin/furan impurities may be formed during some chemical manufacturing processes, EPA issued a rule under Section 4 of the Toxic Substances Control Act (TSCA) that requires chemical manufacturers and importers to test for the presence of chlorinated and brominated dioxins and furans in certain commercial organic chemicals. This TSCA Dioxin/Furan Test Rule (52FR 21412-21452) was established to aid in the identification of the hazards posed by exposure to these dioxin and furan impurities. In addition, it helps to identify which chemical processes produce high and which produce low amounts of dioxins and furans as

by-products and thus leads to the adoption of safer technologies in the production of commercial chemicals.

Pesticide Product Restrictions under FIFRA. During the 1980s, EPA took several actions to investigate and control dioxin contamination of pesticides by certain pesticide active ingredients, particularly chlorinated phenols and their derivatives (e.g., pentachlorophenol (PCP), Silvex, and 2,4,5-T). In 1983, under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), EPA canceled the sale of Silvex and 2,4,5-T for all uses (USEPA, 1998). On January 21, 1987, EPA issued a "Final Determination and Intent to Cancel and Deny Applications for Registrations of Pesticide Products Containing Pentachlorophenol (Including but not limited to its salts and esters) for Nonwood Uses," which prohibited the registration of PCP and its salts for most nonwood uses (52FR 2282-2293). However, EPA deferred action on several non-wood uses (i.e., uses in pulp/paper mills, oil wells, and cooling towers) until additional exposure, use, and ecological effects data could be obtained. EPA entered into a Settlement Agreement in 1987 with PCP manufacturers to allow continued registrations for wood uses (52FR 140-148), on a restricted basis. Restrictions included tolerance levels for specific dioxin congeners. 2,3,7,8-TCDD levels were not allowed to exceed 1.0 ppb in any product, and after February 2, 1989, any manufacturing-use PCP released for shipment could not contain hexa-chlorinated dioxins at levels that exceeded an average of 2 ppm over a monthly release or a batch level of 4 ppm. On January 8, 1993, EPA issued a press advisory stating that the EPA Special Review of these deferred nonwood uses was being terminated, because all of these uses either had been voluntarily canceled by the registrants or had been canceled by EPA for failure of the registrants to pay the required annual maintenance fees (USEPA, 1993f). Today, PCP is designated as a "Restricted Use Pesticide." Restricted use pesticides can only be applied by, or under the supervision of, a trained certified pesticide applicator. Currently under FIFRA, PCP is an approved preservative for poles, crossarms, posts, land and freshwater piling, and various other commodities. However, the primary use of PCP is in utility poles (AWPI, 1999).

In addition to requiring the above pesticide cancellations and standards, EPA's Office of Pesticide Programs (OPP) issued two Data Call-Ins (DCIs) in 1987. Pesticide manufacturers are required to register their products with EPA in order to market them commercially in the United States. Through the registration process, mandated by FIFRA, EPA requires a series of strict tests under 40CFR 158 – Pesticide Assessment Guidelines. If EPA requires additional data to adequately assess a product, this can be obtained through the Data Call In (DCI) process. The first data call in of 1987 was to gather information on the raw materials and manufacturing processes of 93 pesticides to assess those which may contain dioxin and furan contaminants. The second DCI was for analytical testing for dioxins and furans in 68 pesticides suspected to be contaminated. Of the 161 pesticides included in the two DCIs, 92 are no longer manufactured, 43 were declared not likely to contain dioxin/furan contaminants, seven are still having their process data evaluated, thirteen were free of dioxins and furans based on analyses, four are undergoing data generation, and two were found to contain dioxins/furans above the level of quantitation (2,4-D and 2,4-D 2-ethyl hexyl acetate) (USEPA, 1998).

4.2 Source Specific Regulatory Control of Dioxin

Source or sector specific federal, state, and local regulations for several of the major dioxin sectors are discussed in the following section. Table 4 below summarizes the major regulations relevant to dioxins/furans, within the specific context of the major dioxin sources. For relevant sectors, available information pertaining to compliance status is detailed, including: progress in MACT promulgation at the federal level, federal-state interactions, and the status of state implementation of the federal regulations. The sectors addressed in Table 4 include all dioxin sources that are estimated to represent over 1% of total national emissions in 1995, as based on the '98 Dioxin Inventory, as well as other potentially significant sources, some of which have not been quantified in the inventory. As the overwhelming majority of dioxin releases to environmental media (with the exception of PCP treated products) have been determined to be air emissions, the discussion below primarily focuses on regulations that have the potential to reduce air emissions.

Table 4. Dioxins/Furans Regulations for Selected Sources* in the Great Lakes Basin

Source (% of Inventory)	Federal Regulations: Air Releases	Federal Regulations: Water Discharges	Federal Regulations: Waste/Product Management	Federal Regulations: Reporting Requirement and Spills	State / Local Regulations
MUNICIPAL, COMMERCIAL, RESIDENTIAL COMBUSTION SOURCES					
Municipal Solid Waste Combustors (40.1%)	**CAA 112,129**: MACT standards for new and existing MSW combustors (60FR 65387; amended 60FR 65387) **Status:** Large facilities (>250 ton/day): Rule and Federal Implementation Plan finalized; latest date for compliance is December, 2000 Small facilities (35-250 ton/day): Rule proposed Other: Planned MACT for very small MWC, CIWI, and OSWI	lack of data on water releases	**RCRA:** Municipal solid waste (and MSW ash) is specifically excluded from being a listed hazardous waste (40CFR 261.4) and may be disposed of in a municipal landfill. MWC ash may be regulated as hazardous under Subtitle C if it exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	**SARA / EPCRA**: MWC not included in TRI reporting	**CAA: MACT implementation for large MWC** – Approved state plans: NY, IL, MN – Final plans under review: MI, IN, PA – Adopting Federal Plan: OH – No relevant facilities: WI
Medical Waste Incinerators (17.4%)	**CAA 112,129**: MACT standards for new and existing HMIWI (62FR 48348) **Status**: Rule finalized; Federal Implementation Plan proposed (final due in 2000); latest date for compliance is September, 2002.	lack of data on water releases	**RCRA:** Medical waste ash is not a listed hazardous waste and may be disposed of in a municipal landfill. MWC ash may be regulated as hazardous under Subtitle C if it exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	**SARA / EPCRA**: HMIWI not included in TRI reporting	**CAA: MACT implementation** for HMIWI – Approved state plans: IL – Final plans under review: NY, MI, PA – Draft plans submitted: IN, MN, OH – Adopting Federal Plan when approved: WI Each state usually has it's own medical waste program, including ash disposal regulations.

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Source (% of Inventory)	Federal Regulations: Air Releases	Federal Regulations: Water Discharges	Federal Regulations: Waste/Product Management	Federal Regulations: Reporting Requirement and Spills	State / Local Regulations
Forest, Brush, Straw Fires (7.6%)	- Other U.S. government agencies have the lead on wildland fire management - EPA issued an Interim Air Quality Policy on Wildland and Prescribed Fires in 1996 (efforts to control emissions from prescribed burning are focused on the control of particulate matter)				*need information*
Hazardous waste burning cement kilns (5.6%) *Note: Emission estimate for this sector is expected to be revised and significantly lower in the Final Inventory*	**CAA 112,129**: MACT standards for new and existing Hazardous Waste Incinerators (including hazardous waste-burning cement kilns) **Status**: Rule finalized on September 30, 1999 (64FR 52827) (under joint authority of CAA and RCRA);latest date for compliance is September, 2002.	lack of data on water releases	**RCRA:** Hazardous waste ash carries the RCRA-listing of the hazardous waste burned and must be disposed of accordingly under Subtitle C Land Disposal Restrictions, (40CFR 268) and Universal treatment standards for dioxin-containing wastes (40CFR 268.48)	**SARA / EPCRA**: Dioxin reporting required for cement kilns under October1999 TRI Amendment**	*need details on status of state implementation*
Industrial / Utility coal combustion (2.7%)	**CAA:** Utilities exempt from sources that will require MACT standards CAA 111: New Source Performance standards for fossil fuel/steam power generators do not include dioxins	**CWA:** No detectable dioxin allowed in effluent from steam electric power generators (40CFR423) lack of data on water releases	**RCRA:** Ash generated primarily from the combustion of fossil fuels is specifically excluded from being a listed hazardous waste (40CFR 261.4) and may be disposed of in a municipal landfill. Ash may be regulated as hazardous under Subtitle C if it exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	**SARA / EPCRA**: Dioxin reporting required for coal combustion under October1999 TRI Amendment**	*need information*

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Source (% of Inventory)	Federal Regulations				State / Local Regulations
	Air Releases	**Water Discharges**	**Waste/Product Management**	**Reporting Requirement and Spills**	
Residential wood combustion (2.3%)	**CAA:** Certification / NSPS for particulate matter for stoves manufactured after1990	n/a	n/a	n/a	*need information*
Vehicle fuel (diesel) combustion (1.2%)	none uncovered for this source at the time of this report preparation	n/a	n/a	n/a	*need information*
Industrial wood combustion (1.1%)	none uncovered for this source at the time of this report preparation	lack of data on water releases	**RCRA:** Ash may be regulated as hazardous under Subtitle C if it is a listed waste (40CFR 261.31-33) or exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	n/a	*need information*
Residential trash burning / open barrel burning ([1000] [a] g TEQ/yr)	Open burning is not regulated by the CAA. Individual state, county, tribal and local governments have various regulations addressing open burning.	n/a	n/a	n/a	– MN prohibits open burning except on farms or with a permit – IL and NY require a permit for any burn – OH, PA and IN prohibit open burning in certain areas, municipalities, or counties – MI and WI generally allow open burning, but local ordinances may prohibit
Landfill fires ([1000] [a] g TEQ / yr)	none uncovered for this source at the time of this report preparation				

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Source (% of Inventory)	Federal Regulations				State / Local Regulations
	Air Releases	**Water Discharges**	**Waste/Product Management**	**Reporting Requirement and Spills**	
MANUFACTURING AND METALLURGICAL PROCESSES					
Secondary copper smelting (19.7%) *Note: Emission estimate for this sector is expected to be revised and significantly lower in the Final Inventory*	**CAA:** No dioxin regulations for this source under the CAA	**CWA:** NPDES permits may include dioxin monitoring / effluent limits (lack of data on water releases)	**RCRA:** Wastes from the copper industry may be regulated as hazardous under Subtitle C if it is a listed waste (some copper industry wastes are K-listed) (40CFR 261.31-33) or exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	**SARA / EPCRA**: Dioxin reporting required for smelters under October1999 TRI Amendment** CERCLA: facilities must report spills/releases of Dioxin in quantities > 1 lb. to National Response Center	*need information*
Ferrous metal sintering plants ([100] [a] g TEQ / yr)	**CAA:** No dioxin regulations for this source under the CAA	**CWA:** NPDES permits may include dioxin monitoring / effluent limits (lack of data on water releases)	**RCRA:** Waste from iron sintering may be regulated as hazardous under Subtitle C if it is a listed waste (some iron and steel industry wastes are K-listed) (40CFR 261.31-33) or exhibits toxicity characteristics; there are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24)	**SARA / EPCRA**: Dioxin reporting required for ferrous sintering under October1999 TRI Amendment** CERCLA: facilities must report spills/releases of Dioxin in quantities > 1 lb. to National Response Center	*need information*

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Source (% of Inventory)	Federal Regulations				State / Local Regulations
	Air Releases	**Water Discharges**	**Waste/Product Management**	**Reporting Requirement and Spills**	
Pentachlorophenols (25,000 g TEQ / yr were estimated to be in PCP products which represented 99.8% of dioxin/ furan releases to products)	**CAA**: Wood treatment deleted from list of source categories for HAPs (61 FR 28197) (Wood preserving sector being studied in the Dioxin Exposure Assessment (Draft))	**CWA**: Some NPDES permits for PCP manufacturing or processing facilities include dioxin monitoring (lack of data on water releases)	**FIFRA**: PCP registration restricted to wood use only (52FR 2282-2293) **RCRA**: Many wastes from the wood preserving industry are F-listed (40CFR 261.31) and K-listed (40CFR 261.33) hazardous wastes, or exceed the specific toxicity characteristic thresholds for pentachlorophenols (40CFR 261.24); as such, these wastes are regulated under Subtitle C Land Disposal Restrictions for Wood Preserving Wastes (40CFR 268, Subpart C) and Universal treatment standards for dioxin-containing wastes (40CFR 268.48). PCP treated utility poles may only be designated as hazardous if they meet the definition of a waste and exceed the toxicity characteristic threshold for PCP (40CFR 261.24)	**SARA / EPCRA**: Dioxin reporting required for facilities manufacturing, processing, or using PCPs that contain dioxin as a contaminant under October1999 TRI Amendment** **CERCLA**: facilities must report spills /releases of Dioxin in quantities > 1 lb. to National Response Center TSCA Sections 4,8 Dioxin/Furan Test Rule: Dioxin testing and reporting requirements for manufacturers of designated chemical substances (40CFR 766)	*need information*

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Source (% of Inventory)	Federal Regulations				State / Local Regulations
	Air Releases	**Water Discharges**	**Waste/Product Management**	**Reporting Requirement and Spills**	
OTHER SOURCES					
Hazardous Waste Incinerators (<1%)	**CAA 111,129**: MACT standards for new and existing Hazardous Waste Incinerators Status: Finalized on September 30, 1999 (64FR 52827); latest date for compliance is September, 2002. (Under joint authority of CAA and RCRA)	lack of data on water releases	**RCRA:** Hazardous waste ash carries the RCRA-listing of the hazardous waste burned and must be disposed of accordingly under Subtitle C Land Disposal Restrictions, (40CFR 268) and Universal treatment standards for dioxin-containing wastes (40CFR 268.48) RCRA: Hazardous Waste Disposal Rules for dioxins (40CFR 261-268, Subpart D; 40CFR 270)(restricted waste) *[to CHECK]*	**SARA / EPCRA**: Dioxin reporting required for hazardous waste incinerators under October1999 TRI Amendment** **CERCLA:** facilities must report spills /releases of Dioxin in quantities > 1 lb. to National Response Center	*need information*
Pulp & Paper Mills (45 g TEQ / yr released to air, water, land and products combined)	**Pulp&Paper Cluster Rule** promulgates NESHAPS/MACT standards for Pulp&Paper Source Category	**Pulp&Paper Cluster Rule** promulgates NPDES dioxin effluent standards and pretreatment requirements for Bleached Papergrade Kraft and Soda Subcategory and the Bleached Papergrade Sulfite Subcategory	**TSCA section 6(a)** Pulp and paper biosolids regulated for dioxin (40CFR 744) *[to CHECK]*	**SARA / EPCRA**: Dioxin reporting required for Pulp and Paper Mills under October1999 TRI Amendment**	*need information*

* Except where noted, sources listed include those that are greater than 1% of the 1998 U.S. Draft Dioxin Inventory (i.e., >27.4 g TEQ / yr), based on air emissions of ~ 2745 g TEQ / yr.

** October 29, 1999 Final TRI Amendment adds dioxins and some dioxin-like compounds to those chemicals subject to TRI reporting requirements, with a reporting threshold of 0.1 gram/year (64 FR 58666).

[a] A number in square brackets indicates the order of magnitude estimate for this source; this number is not included in the calculation of emission totals.

Municipal Waste Combustors. In December 1995, EPA finalized Emission Guidelines for existing MWCs and standards of performance for new stationary MWCs under the Clean Air Act. This was followed in August 1997 with the release of an amendment to the 1995 regulation which called for the exemption of small MWC units and cement kilns (firing municipal solid waste) from coverage under the 1995 regulations. Consequently, the 1995 regulations apply only to MWC units with the capacity to combust more than 250 tons per day of municipal solid waste (i.e., large MWC units). EPA addresses small MWC units and cement kilns in separate rulemakings.

Thus, Emission Guidelines and standards of performance for Large MWC Facilities (>250 tons / day) were promulgated with the 1995 rulemaking (40CFR Part 60, Subparts Eb and Cb) (Final 12/95 60FR 65387). Section 129 requires that a State Plan at least as protective as the Guidelines be developed in States with existing MWC (State Plans were due by December 19, 1996). Once approved, State Plans become Federally enforceable. If a State with existing MWC units did not submit an approvable plan to EPA within two years of the final MWC emission guidelines (i.e., by December 19, 1997), EPA is required to develop, implement, and enforce a Federal plan for MWC units in that State. A federal plan was finalized in November, 1998 (63FR 63191).

The Guidelines specifically require that (state) implementation plans include an accelerated compliance schedule for dioxins/furans. MWC units for which construction commenced after June 26, 1987 and that are located at large MWC plants are required to be in compliance with the dioxin/furan guidelines within 1 year following issuance of a revised construction or operation permit, if a permit modification is required, or within 1 year following approval of the State Plan, whichever is later. Otherwise, final compliance is required within 3 years of the approval of a State Plan or by December 19, 2000, whichever is first (USEPA, 1995; USEPA, 1998a).

State Plans for large MWCs were required to be submitted to EPA within 1 year after the promulgation of the Guidelines, i.e., State Plans were due on December 19, 1996. Within the Great Lakes Basin three (out of eight) states currently have approved state plans, three states have final plans under review, one state is adopting the Federal Plan, and one state has no relevant facilities. If a State with an existing large MWC does not submit an approvable plan, EPA is required to develop, implement, and enforce a Federal Plan for MWC in the State. The MWC Federal plan for the implementation of MWC emission guidelines in States without approved State Plans was finalized on November 12, 1998 (63FR 63191). The Federal Plan ensures that large MWC facilities complete pollution control upgrades on schedule to meet the final compliance deadline of December 19, 2000.

For Small MWC Facilities (35 - 250 tons/day), NSPS and Emission Guidelines have been proposed (40CFR Part 60, Subparts AAAA and BBBB) (Proposed 8/99 64FR 47275 and 47233) and are planned to be finalized by 2001. State plans must specify that all Class A and Class B small MWC units for which construction, modification, or reconstruction commenced after

June 26, 1987 comply with the emission guidelines for mercury and dioxins/furans within: (1) 1 year following issuance of a revised construction or operation permit if a permit modification is required, or, (2) 1 year after the effective date of State plan approval if a permit modification is not required. Otherwise, in no case can compliance be later than 5 years after final promulgation of these emission guidelines. (USEPA, 1999b).

Although MWC plants with aggregate plant capacities to combust 35 tons /day or less of MSW are not currently subject to regulations, NSPS and Emission Guidelines for Very Small MWCs, as well as Commercial and Industrial Waste Incinerators (CIWIs), and Other Solid Waste Incinerators (OSWIs) are planned. The commercial/industrial waste incineration rule is planned to be finalized by November 15, 2000.

Municipal waste incinerators also generate fly ash (ash caught in the pollution control equipment) and bottom ash which are contaminated with varying levels of dioxin (USEPA, 1998). Under RCRA, waste comprised of only household/municipal waste is specifically excluded from being a listed hazardous waste (40CFR 261.4) and therefore does not need to be disposed of in a hazardous waste landfill, but must be disposed of in a permitted municipal landfill. However, if MWC ash tests hazardous using the RCRA Toxic Characteristic Leaching Procedure (i.e., it exhibits ignitability, corrosivity, reactivity, or toxicity characteristics), it must be managed as a hazardous waste under RCRA Subtitle C. There are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24). More information is needed on current practices related to both the testing and handling of fly and bottom ash from MWC plants.

Medical Waste Incinerators. NSPS and Emission Guidelines for Hospital/Medical/ Infectious Waste Incinerators (HMIWIs) were promulgated in September 1995 (40CFR Part 60, Subparts Ec and Ce) (Final 9/95 62FR 48348). Separate Emission Guidelines have been established for three categories of HMIWI, based on the waste burning capacity of the facility. The emission guidelines also contain optional (less stringent) emission limits for small "rural" (< 200 pounds /hour) facilities (USEPA, 1997a).

The Federal/State interaction involved in implementing HMIWI regulation is generally similar to that involved in MWC regulation implementation, i.e., Section 129 requires that a State Plan at least as protective as the Guidelines be developed in States with existing HMIWI, and that EPA develop, implement, and enforce a Federal Plan for HMIWIs in States that do not submit an approvable plan. On July 6, 1999, EPA proposed a Federal Plan (64FR 36426) for the implementation of HMIWIs emission guidelines in States without approved State Plans. Full compliance with an approved State Plan is required within 1 year after EPA approval, or within 3 years (i.e., by 9/02) provided that the State Plan includes measurable and enforceable incremental steps of progress. State Plans implementing the emission guidelines for HMIWI were due by September 15, 1998 (i.e., within 1 year of EPA 1997 promulgation of the Emission Guidelines (62FR 48347). Within the Great Lakes Basin one (out of eight) states currently has an approved State Plan, three states have final plans under review, three states have draft plans submitted, and

one state is adopting the Federal Plan when it is approved. As previously discussed, standards and guidelines for medical waste incinerators are expected to reduce dioxins from these sources to about 6-7 g TEQ/year when fully implemented in 2002 (Winters, personal communication, 2000). EPA expects Emission Guidelines for existing HMIWIs to result in a nationwide emissions reduction from these facilities of 141-143 g TEQ/yr (from a regulatory baseline of 148 g TEQ/yr). EPA expects the guidelines to result in the discontinued use of as many as 50 to 80 percent of the estimated 2,400 existing HMIWIs. In the first 5 years after promulgation, the NSPS are expected to apply to about 10 to 70 new HMIWI (by the year 2002), with expected nationwide emission reductions of 0.8 to 0.93 g TEQ/yr (based on a 1.1 g TEQ/yr regulatory baseline). For both HMIWI emission guidelines and NSPS standards, reduction estimates represent reductions from the regulatory baselines, which are calculated as emissions that would occur in the absence of the MACT emission guidelines and standards (62FR 48347).

Medical waste incinerators also generate ash that may be contaminated with varying levels of dioxin (USEPA, 1998). Under RCRA, medical waste ash is not a listed hazardous waste and may be disposed of in a municipal (non-hazardous) landfill (40CFR 261.4). However, if HMIWI ash tests hazardous using the RCRA Toxic Characteristics Leaching Procedure (i.e., it exhibits ignitability, corrosivity, reactivity, or toxicity characteristics), it must be managed as a hazardous waste under RCRA Subtitle C. There are no toxicity characteristic thresholds for dioxin specifically (40CFR 261.24). Medical waste and medical waste incinerator ash is also often regulated under a state's own medical waste management program. More information is needed on current practices related to both the testing and handling of fly and bottom ash from HMIWI plants.

Hazardous Waste Burning Cement Kilns. Air emissions standards for Hazardous Waste Combustors (HWCs), including cement kilns that burn hazardous waste as a fuel, have been developed by the Office of Solid Waste under the joint authority of CAA Section 112 and RCRA. The standards, as specified by the CAA, reflect the performance of Maximum Achievable Control Technologies (MACT), and were finalized on September 30, 1999 (64FR 52827). Compliance with the promulgated rules is required within 3 years of the effective date of the final rule (i.e., by September 30, 2002) (64FR 52827). Existing Sources and New Sources (those beginning construction or reconstruction after April 19, 1996) are subject to differing standards. Implementation of the MACT standards is carried out through the air program, including operating permit programs developed under Title V. All sources subject to the HWC MACT rule will have to obtain both RCRA and Title V permits which will each address different aspects of the facility. Title V permits will focus on the combustors' operations, and RCRA permits will focus on other basic aspects of hazardous waste management. The final rule integrates the monitoring, compliance testing, and record keeping requirements of the differing CAA and RCRA compliance schemes, so there should be no duplicative requirements between the two permits.

EPA will implement the MACT standards until they are delegated to the states (enforced under that states' Title V permitting authority). Most of the RCRA provisions are promulgated

under the authority of the Hazardous and Solid Waste Amendments (HSWA), which means that they take effect in all states - both authorized and unauthorized - at the same time, and are implemented by EPA until the state receives authorization. Combustion facilities will have three years to comply with the standards; facilities making manufacturing process changes may petition for four years to meet the new standards. Promulgation of the combustion "Fast Track Rule" on June 19, 1998 also provides facilities with several incentives to use waste minimization/pollution prevention measures to achieve compliance (e.g., provides a one year compliance extension for those facilities submitting evidence that installing source reduction and/or recycling measures to bring the facility into compliance requires an extra year). Emission standards for Hazardous Waste Combustors are expected to result in significant reductions in dioxin/furan emissions from these facilities (incinerators, cement kilns, and lightweight aggregate kilns combined) with full compliance in 2002.

Within the Great Lakes Basin one state has an approved state implementation plan for hazardous waste burning cement kilns, one state has a draft plan submitted, and two states have verified that they have no relevant facilities. Information on the status of State implementation of HWC standards in the other states in the Great Lakes Basin is needed.

Ash generated at cement kilns combusting hazardous waste carries the RCRA listing of the hazardous waste burned and must be disposed of accordingly under Subtitle C Land Disposal Restrictions, (40CFR 268) and Universal Treatment Standards for dioxin-containing wastes (40CFR 268.48).

Secondary Copper Smelting. Although there are currently no regulations controlling dioxin air emissions from the secondary copper smelting industry, this sector is on list of additional source categories EPA intends to include in its final strategy under 112(k). Comment is still under request for this source category (63FR 49249).

Open Barrel Trash Burning. There is currently no federal legislation that addresses barrel/backyard trash burning. However, many states, municipalities, and local communities have ordinances that prohibit or restrict burning of household waste. These ordinances may vary between and within states. For example, in Indiana's four ozone non-attainment counties, Lake, Porter, Clark, and Floyd, all open burning is illegal (except under certain circumstances, leaves may be burned in these counties if allowed by a local ordinance). In all other Indiana counties, state law permits open burning if the burning is done according to certain restrictions. In Illinois, a permit is required for any open burn (there are currently about 70 active permits for open burning in Illinois), although the state suspects that permits are often not obtained for smaller, less conspicuous fires. A permit for open burning of garbage is also required by state law in Minnesota, except on farms without commercial waste removal service. In Ohio, open burning regulations vary depending whether the area is restricted (i.e., within 1000 feet of city limits) or unrestricted. In New York and Pennsylvania, state laws generally prohibit and/or require a permit for open burning of garbage and many types of waste materials. This is in contrast to

Michigan and Wisconsin, where open burning is generally permitted by state law and if any restrictions exist, they are enforced on a local, countywide, or regional basis.

Landfill Fires. Information is needed on state and/or local regulations pertaining to controls on intentional and unintentional landfill fires.

Ferrous Metal Sintering Plants. The Iron and Steel Foundry category MACT standard is scheduled to be issued by the year 2000. EPA's Office of Air Quality Planning and Standards (OAQPS) performed stack test on two different sintering plants for the purpose of testing for MACT standard development, as well as to determine how much dioxin is being emitted from the sintering plants. Preliminary analysis indicates that emissions from sintering plants are relatively low (i.e., in comparison to the total inventory) (Winters, personal communication, 2000). Revised estimates should be available in the Final Inventory.

Industrial / Utility Coal Combustion. Although there are currently no federal or State restrictions on dioxin emissions from coal-fired utilities, Section 112(n)(1)(A) of the CAAA requires EPA to regulate HAP emissions from electric utilities. EPA has been congressionally required to defer regulation until the findings of a National Academy of Science (NAS) Report is completed (July 2000). Results from this NAS report, and the results from the Utility Air Toxics Study, will be used to decide whether the Agency will regulate utility boilers. This determination will be completed by December 2000. Although mercury emissions are the primary focus of the recent utilities studies, any stricter mercury emission control may also aid in reducing dioxin emissions from this sector. In addition, EPA will be implementing the new National Ambient Air Quality Standards for fine particulate matter and ozone and the second phase of the acid rain program; actions that power plants may take to reduce their emissions of the greenhouse gases could also reduce dioxin emissions from utilities.

EPA has concluded that fossil fuel combustion wastes do not warrant regulation as hazardous under Subtitle C of RCRA and on April 25, 2000, announced that the Agency is retaining the hazardous waste exemption for these wastes. However, the Agency has determined that national non-hazardous waste standards under RCRA Subtitle D are needed for coal combustion wastes disposed in surface impoundments and landfills and used as minefilling. The national standards to be developed would focus on protection against possible groundwater contamination. EPA also concluded that beneficial uses of these wastes, other than for minefilling, pose no significant risk and no additional national regulations are needed. This determination affects more than 110 million tons of fossil fuel combustion wastes that are generated each year, virtually all from burning coal (USEPA Press Release, 2000a).

Residential Wood Combustion. To control particulate matter (PM) emissions from residential wood combustion, a 1988 New Source Performance Standard (NSPS) requires EPA certification for residential wood-fired heaters manufactured after 1990. The certification is based on a PM emission rate limit of 7.5 grams per hour and is expected to reduce PM emissions from new wood stoves. Although the exact nature of the association between dioxins/furans and PM is unknown, PM controls on wood stoves may also aid in reducing dioxin/furan emissions

from new wood stoves. The NSPS does not apply to fireplaces and other wood-burning devices such as masonry heaters that do not meet the definition of "affected facility" in the NSPS. Although this standard has been in effect for nearly ten years, only about 11 percent of wood stoves in the U.S. are EPA-certified. The phase-out of older wood-fired heaters that do not meet EPA's PM limit is slow to take effect. Industry associations, such as the Hearth Products Association, are taking measures to accelerate the replacement of older wood stoves, as well as to provide education on clean burning techniques that result in lower PM emissions. These efforts are discussed in Section 5.2.2.

Pentachlorophenol (PCP) Treated-Wood. As discussed in Section 4.1, PCP registration is restricted to wood uses only (52FR 2282-2293). In the U.S. today, PCP is used predominantly as a wood preservative for utility poles and crossarms although other uses, e.g., for posts and land and freshwater pilings, have also been reported (AWPI, 1999) (USEPA, 1998). There are more utility poles treated with PCP than any other preservative. Since 1970, PCP has been used to treat approximately 50 percent of the utility poles produced (AWPI, Penta Council, 1999). Under FIFRA, EPA is currently evaluating PCP for re-registration. This evaluation will result in a Re-registration Eligibility Decision Document (RED), due to be released in 2000, that will determine any revisions in regulatory requirements relating to PCP use. The results of the RED process could impact the feasibility of various pollution prevention and emission reduction options.

Under RCRA, many wastes from the wood preserving industry are F-listed (40CFR 261.31) and K-listed (40CFR 261.33) hazardous wastes. However, PCP-treated wood itself is not a listed hazardous waste, and is not itself considered a pesticide (i.e., not regulated under FIFRA). If a PCP-treated product that is a waste, or other PCP industry waste, meets the definition of a hazardous waste, via listing or toxicity characteristics, these wastes are regulated under Subtitle C Land Disposal Restrictions for Wood Preserving Wastes (40CFR 268, Subpart C) and Universal Treatment Standards for dioxin-containing wastes (40CFR 268.48). Although there are no specific requirements for testing or regulatory thresholds for dioxins or furans under RCRA, the RCRA toxicity characteristic test requirements (i.e., the Toxicity Characteristic Leaching Procedure (TCLP)) set the maximum concentration of pentachlorophenols for the toxicity characteristic at 100 mg/L for the TCLP leachate (40CFR 261.24).

In addition, utility poles taken out of service may not necessarily be considered a waste and can be reused consistent with their intended end use. PCP treated utility poles that are taken out of service can only be designated as hazardous if they meet the definition a waste (40CFR 261.2) and exceed the toxicity characteristic threshold for PCP (40CFR 261.24). Poles that are no longer acceptable for carrying power lines are often used for fence posts, landscape materials or supports for vehicle shelters. In fact, through its WasteWise program, EPA OSWER endorses the re-use of used utility poles for such things as landscaping, for constructing gates and barriers, as fencing, in the construction of playground equipment, and for hiking trails (USEPA, 1997c). The utility that generates used PCP-treated utility poles is responsible for determining the regulatory status of the used poles and ensuring that management and disposal are in concert with

local, state, and federal regulations. Many utilities distribute waiver forms, disclosure information, and material safety sheets when selling or giving away poles. Another alternative for recycling is the use of PCP-treated wood for fuel in industrial or commercial boilers or furnaces with capacities in excess of 20 million Btu/hr. There are a number of facilities in the U.S. that have been permitted to combust PCP-treated wood (AWPI, Penta Council, 1999).

Pulp and Paper Mills. In April 1998, EPA promulgated the pulp and paper cluster rule under joint CAA and CWA authority. (The Pulp & Paper Cluster Rule is under the statutory authority of Section 112(b) of the CAA and Sections 304(b) and 307 of the CWA.) This rule represents the Agency's first integrated, multi-media regulation aimed at controlling the release of pollutants to more than one medium from one industry. The Final Pulp, Paper, and Paperboard "Cluster Rule" (63FR 18504) sets new baseline limits for releases of toxics and nonconventional pollutants, including dioxins and furans, to air and water. National Air Emissions Standards for Hazardous Air Pollutants (NESHAPs) require sources within the pulp and paper category to control dioxins using Maximum Achievable Control Technology (MACT), specifically emissions that occur during the pulping and bleaching processes. Water effluent limitations (NPDES) and pretreatment standards require facilities within the Bleached Papergrade Kraft and Soda subcategory and the Papergrade Sulfite subcategory to limit, based on Best Available Technology (BAT), dioxins in the wastewater discharged during the bleaching process and in the final discharge from the mills. EPA projects that nationally, 155 of the 565 mills in the U.S. will be required to regulate toxic air pollutants and comply with MACT standards, and that 96 of the 155 will additionally be subject to the effluent limitation guidelines and standards promulgated in the Pulp & Paper Cluster Rule. The new air and water standards under the pulp and paper cluster rule are expected to reduce dioxin and furan discharges to water by 96 percent and, ultimately, eliminate all dioxin fish consumption advisories associated with the 96 mills affected by this action (63FR 18504, April 15, 1998).

5.0 PROGRAMS AFFECTING DIOXINS/FURANS REDUCTION

The following section summarizes the major programs, activities, and non-regulatory efforts that may directly or indirectly address issues related to dioxin/furans in the Great Lakes. The programs include emissions reduction, restoration of impacted areas, mitigation of exposure, and research to improve understanding of dioxin sources and pathways of exposure in the Great Lakes.

5.1 Binational and International Programs

Binational Toxics Strategy. As discussed in the introduction to this report, the U.S. EPA and Environment Canada agreement under the Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin (also known as the Great Lakes Binational Toxics Strategy (GLBTS)), marks the first time that specific reduction targets for toxic pollutants have been jointly set by both countries. Reduction efforts under this

program are based primarily on voluntary pollution prevention activities, but also build on existing Canadian and U.S. regulatory programs. The GLBTS provides an established process for engaging stakeholders and seeking voluntary reduction efforts through a Dioxins/Furans Workgroup. The workgroup offers an opportunity for EPA to solicit and recognize efforts toward the virtual elimination of dioxin in the Great Lakes. An additional challenge of the GLBTS is to assess atmospheric inputs of strategy substances to the Great Lakes and, if long-range sources are confirmed, to work within international frameworks to reduce releases of such substances. The GLBTS also sponsored an incineration workshop focusing on municipal waste combustion in May 2000.

International Joint Commission Critical Pollutant. Canada and the United States, recognizing that lake and river systems along the border are affected by each country, created the International Joint Commission (IJC). In 1972, Canada and the United States signed the first Great Lakes Water Quality Agreement and gave the IJC the authority to make recommendations on implementing this Great Lakes Water Quality Agreement (GLWQA). The IJC established a policy that the discharge of any or all persistent toxic substances will be virtually eliminated from the Great Lakes Basin Ecosystem. In 1978, a new agreement was signed in which a commitment was added by the U.S. and Canada to work together to rid the Great Lakes of persistent toxic substances, including dioxins/furans. In 1987, the U.S. and Canadian governments signed a Protocol under the Great Lakes Water Quality Agreement which included the development of "Lakewide Management Plans" and "Remedial Action Plans" for "Areas of Concern". The Commission is responsible for the review of these documents, described below.

Great Lakes Lakewide Management Plans. The U.S. and Canadian governments agreed to develop Lakewide Management Plans (LaMPs) for the five Great Lakes under Annex 2 of the 1987 Great Lakes Water Quality Agreement. Both the U.S. and Canadian governments have responsibility for developing LaMPs for each of the Great Lakes, with the exception of Lake Michigan LaMP, which is being developed solely by the U.S. The purpose of the LaMPs is to assess targeted toxic pollutants of concern (critical pollutants) as they relate to the impairment of beneficial uses of the Great Lakes and to develop measures to restore beneficial uses where they have been impaired. Dioxin has been identified as a critical pollutant in Lakes Erie, Michigan, Ontario, and Superior.

Remedial Action Plans (RAPs) for Great Lakes Areas of Concern (AOCs). The Great Lakes Remedial Action Plan (RAP) program originated from a 1985 recommendation made by the International Joint Commission's Great Lakes Water Quality Board and was formalized in the 1987 amendments to the GLWQA. The aim of RAPs is to restore beneficial uses in 43 Areas of Concern (AOCs) identified in the Great Lakes Basin where beneficial uses or the area's ability to support aquatic life have been impaired. Through the RAP program, Canada and the U.S. are committed to cooperating with state and provincial governments to incorporate a systematic and comprehensive ecosystem approach to address critical pollutants, to restore

beneficial uses, and to ensure that the public is consulted in all actions undertaken to develop and implement RAPs for designated AOCs. Dioxins contribute to impaired uses in several AOCs.

United Nations Environment Program (UNEP) Persistent Organic Pollutants (POPs) Initiative. In February 1997, UNEP's Governing Council requested the Executive Director to prepare for and convene an intergovernmental negotiating committee, with a mandate to prepare an international legally binding instrument for implementing international action, initially beginning with twelve specific persistent organic pollutants (POPs), including dioxins and furans. The Governing Council also noted the need to develop science-based criteria and a procedure for identifying additional POPs as candidates for future international action and requested the intergovernmental negotiating committee to establish, at its first meeting, an expert group to carry out this work. The UNEP POPs negotiations are ongoing. In advance of the treaty, UNEP initiated and contributed to other activities to identify sources of dioxins and furans and to take measures against them to protect public health and the environment. In June 1999, the UNEP Chemicals program released a report summarizing available information on releases of dioxins and furans to the environment. The report covers 15 national inventories.

United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) Initiative. In February 1998, under the United Nations' Economic Commission for Europe Long-Range Transboundary Air Pollution (LRTAP) Convention, 43 countries completed negotiations on a regional Persistent Organic Pollutants (POPs) protocol. The LRTAP Protocol sets a framework for controlling, reducing, and eliminating discharges, emissions, and losses of persistent organic pollutants, including dioxins. Member countries have agreed to control emission levels above a specified baseline year selected by each country (i.e., emissions of dioxins, furans, PAHs and HCB must be reduced below 1990 level). New stationary sources will have two years to reach identified emission levels and existing point sources will have eight years to reach targeted emission levels once the Convention is ratified. For the incineration of municipal, hazardous and medical waste, it lays down specific limit values.

NAFTA. Under the auspices of the North American Free Trade Agreement (NAFTA), a Technical Working Group on Pesticides is coordinating re-evaluation activities and "registration eligibility" for wood treatment applications - including pentachlorophenol, CCA, and creosote - where substances such as dioxins and furans may be present as micro-contaminants.

Commission for Environmental Cooperation Tri-lateral North American Regional Action Plan. The Commission for Environmental Cooperation (CEC) was established by Canada, Mexico, and the United States in 1994 to address transboundary environmental concerns in North America. To address environmental pollutants, the CEC established a Sound Management of Chemicals (SMOC) Working Group to conduct management studies on substances of mutual concern that are persistent, bioaccumulative and toxic. The studies have a two-phased approach, with the goal being a North American Regional Action Plan (NARAP). Although the need for a regional action plan for dioxin and furans has

not yet been finalized under this program, a recommendation has been made to the Working Group on the Sound Management of Chemicals for the nomination of dioxins and furans to be forwarded to the Substance Selection Task Force for consideration of whether development of a North American Regional Action Plan is merited.

5.2 Domestic Programs

5.2.1 Federal and Local Programs Focusing on Dioxin Sources and Emissions

PBT Initiative. On November 16, 1998, the U.S. Environmental Protection Agency (EPA) released its Agency-wide Multimedia Strategy for Priority Persistent, Bioaccumulative, and Toxic (PBT) Pollutants (PBT Strategy). The PBT Strategy targets dioxins and furans as Level 1 pollutants, and building on the GLBTS, seeks to reduce risks from persistent toxic substances, including dioxins/furans, at a national level through the development and implementation of national action plans for priority PBT pollutants. The aim of the PBT Strategy is to respond to the cross-media issues associated with PBT pollutants by going beyond the traditional single-statute approaches in order to reduce risks to human health and the environment from existing and future exposure to PBT pollutants. The PBT strategy is also intended to facilitate the coordination of efforts among all EPA national and regional programs as well as to promote collaboration with international organizations to reduce risks from current and future exposure to dioxin. However, prior to the attention given to dioxins and furans from the PBT Initiative, the Agency had made a commitment, in response to comments received on the draft dioxin reassessment, to develop a national dioxin strategy which addressed cross-media issues. Therefore, the PBT strategy for dioxin and furans will adopt current and previous Agency work on a national dioxin strategy. The PBT national action plan for dioxin is to be completed in conjunction with the Agency's Final Dioxin Reassessment, and once the Dioxin Reassessment is finalized, the included strategy will serve as both the Agency's national dioxin strategy, as well as the PBT strategy to be included in the dioxin/furan action plan.

Voluntary Advanced Technology Incentives Program. This innovative voluntary incentives program was initiated under the Pulp and Paper Cluster Rule, discussed above. Under this program, pulp and paper mills are voluntarily subject to more stringent standards in return for rewards including reduced penalties, increased time for achieving compliance, reduced monitoring and inspection requirements, and public recognition (63FR 18504, April 15, 1998). This program is intended to result in additional long-term reductions in the release of toxics, including dioxins, to water and air.

CAA 112(k) Urban Area Source Program - Integrated Urban Air Toxics Strategy. EPA's Integrated Urban Air Toxics Strategy is a framework for addressing air toxics in urban areas, and identifies dioxins/furans as one of 33 air toxics that present the greatest threat to public health in the largest number of urban areas. Building on its existing air toxics regulatory program, key components of the Strategy are 1) regulations addressing sources at both the national and local level, 2) initiatives to identify and address specific community risks (e.g.,

though pilot projects), 3) air toxics assessments (including expanded air toxics monitoring and modeling) to identify areas of concern, to prioritize efforts to reduce risks, and to track progress, and 4) education and outreach efforts to inform stakeholders about the strategy and to seek input for program design and implementation. In addition, the Strategy also describes EPA's plans to consider and potentially address diesel emissions in the upcoming mobile source air toxics regulation. As diesel fuel has been identified as a suspected source of dioxin, the Urban Air Toxics Strategy may also help to address this mobile source of dioxin emissions.

Waste Minimization National Plan. The Waste Minimization National Plan (WMNP), was developed by EPA's Office of Solid Waste in 1994 to reduce the quantity and toxicity of hazardous waste through source reduction and recycling, including wastes containing dioxin. The plan is a voluntary, long-term effort, with the goal of a 50 percent reduction in the presence of the most persistent, bioaccumulative, and toxic (PBT) chemicals in hazardous waste by 2005 compared to a baseline year of 1991. A final list of chemicals to be targeted in this program is expected to be published in 2000.

Contaminated Sediment Management Strategy. EPA's Contaminated Sediment Management Strategy utilizes a cross-program policy framework to promote consideration and reduction of ecological and human health risks posed by sediment contamination. The strategy advocates cross-program coordination, as well as a watershed approach, to prevent and remediate existing sediment contamination and to prevent future contamination. Actions required to manage legacy contaminated sediment sites as well as sites with existing discharges, include source control, pollution prevention, and remediation.

Wildland Fire Prevention/Education. Wildfires on federal lands are managed by the Forest Service, within the Department of Agriculture, and the Bureau of Land Management, within the Department of the Interior. State and local firefighting organizations respond to wildfires on state and private lands. Various agreements among federal, state, and local firefighting organizations allow for cooperative efforts in providing mutual support in the suppression of wildfires. Prescribed, or controlled burns, may be used to recycle nutrients, reestablish native plant and animal communities, or to reduce the fuel available for dangerous wildfires to ignite. Teams of specialists throughout the U.S. promote local wildland fire prevention efforts by raising public awareness about fire dangers and educating thousands of citizens on how they can prevent unwanted wildland fires.

Western Lake Superior Sanitary District (WLSSD) Pollution Prevention Efforts and Zero Discharge Pilot Project (ZDP). In 1994 the WLSSD, the largest point-source discharger on the American shoreline of Lake Superior, made a commitment to establish a Zero Discharge Pilot Project in its service area as a way to test various strategies for moving the WLSSD closer to the goal of zero discharge of persistent toxic substances. For the Zero Discharge Pilot Project, WLSSD chose to focus on mercury, lead, PCBs, hexachlorobenzene (HCB), and dioxin (2,3,7,8-TCDD), with a goal to develop and implement innovative programs focusing on pollution prevention and source reduction. Efforts have included research to locate

the source of the dioxin in WLSSD sludge, as well as efforts trying to reduce the level of dioxin produced by the treatment facility. Specifically, WLSSD implemented waste separation programs and testing of alternative fuels in the incinerator to determine their effect on the dioxin levels. In a step toward eliminating dioxin from the effluent that is discharged from the facility, the WLSSD applied for and received a variance to discontinue the practice of disinfecting effluent with elemental chlorine. In addition to these internal activities, the ZDP provided input into an Office of Environmental Assistance program which sponsored a public education campaign to discourage the use of backyard burn barrels.

5.2.2 Industry Activities

Health Care Industry Initiatives. Health Care Without Harm (HCWH) is a collaborative campaign for environmentally responsible health care, initiated in 1996 by 28 organizations with the intent of addressing the environmental impacts of medical waste, particularly medical waste incinerators (HMIWIs). One of the primary concerns of the group is reducing dioxin (and mercury) emissions from medical waste incineration. HCWH discourages unnecessary incineration of hospital waste materials, especially recyclable materials, with a focus on eliminating the need to burn wastes. In addition, HCWH is also specifically concerned with products made with polyvinyl chloride (PVC) plastic, due to the potential for PVC to release dioxin during its manufacture and incineration, and di(2-ethylhexyl) phthalate (DEHP) leaching from flexible PVC products.

Wood Stove Changeout Programs and Workshops. Organized by the Hearth Products Association in cooperation with manufacturers, distributers, and retailers of wood-burning stoves, wood stove changeout programs offer substantial trade-in rebates on purchases of advanced technology stoves and fireplaces. Wood-burning workshops are also organized as part of changeout programs for those interested in learning how to make their wood-burning systems more effective and cleaner burning. A pilot wood stove changeout program was held in eastern Ontario in early 1999. In addition, EPA and the Hearth Products Association also sponsored a pilot program in Traverse City, Michigan in February, 2000, with the goal of gauging regional response, level of participation and potential impacts of a wood stove changeover. Another wood stove changeover program is planned to take place in Green Bay, Wisconsin. Generally, those turning in old conventional wood stoves receive a rebate (e.g. 15%) on the purchase of a new stove (as based on an agreement between the manufacturers and the dealerships). Sponsors are also contemplating expanding the changeover projects, pending an assessment of the success in these two areas Other aspects of the project potentially include: partnering with steel industry groups to pick up the old stoves for use as scrap steel, and a certification of destruction requirement from the scrap yard to verify that the old stoves are not being put back into service. In addition, as preliminary assessments show that about one-third of those changing over are switching to liquid fuel or gas units, the gas utilities, insurance companies, and fire departments may be valuable partners in these changeover efforts in the future.

5.2.3 Programs Focusing on Dioxin Exposure Reduction

National Fish and Wildlife Contamination Program and Fish Consumption Advisories. As discussed in previous sections, high levels of dioxin contamination were the cause of 59 fish advisories in 19 states in 1998. State and Tribal governments issue advisories for waterbodies in an effort to reduce health risks associated with exposure to pollutants in certain fish and shellfish species. The EPA has facilitated State and Tribal development and implementation of comprehensive monitoring programs and consistent risk-based fish and wildlife advisory programs by issuing a multi-volume National Guidance on all aspects of how to establish a fully-protective fish consumption advisory program – from sampling and analysis to what works as effective communication. In 1998, EPA requested that States and Tribes review existing fish advisory program approaches and methodologies and compare them with recommendations in EPA's National Guidance. Areas of particular interest included monitoring strategies, risk assessment methods, communication strategies, and overall level of effort. In October of 1999, EPA sponsored a national meeting to provide each State and Tribe an opportunity to present their advisory programs, identify any inconsistencies with the National Guidance, and discuss how inconsistencies can be rectified.

Since 1993, the EPA has published an annual report, *The National Listing of Fish and Wildlife Advisories* (NLFWA), on trends in the number of fish and wildlife consumption advisories. The 1998 update for the LFWA database was recently made available from the EPA, at [http://www.epa.gov/OST/fish/]. This database includes all available information as of December 1998 describing state, tribal, and federally issued fish and wildlife consumption advisories in the United States for the 50 states, the District of Columbia, and four U.S. territories. It has also been recently expanded to include the 12 Canadian provinces and territories. This resource generally has limited usefulness in identifying trends in dioxin contamination levels because increases in fish advisories often indicate an increase in the number of assessments or a more stringent trigger level, rather than an increase in contaminant levels. The database is intended to increase public education, in a "user-friendly" format (e.g., the database can be accessed by pointing and clicking on a map, or by identifying the state, or water body name), regarding risks associated with the consumption of fish containing high levels of toxic contaminants.

EPA and the Agency for Toxic Substances and Disease Registry have sponsored a nationwide effort to inform health professionals and their patients about the dangers of eating fish harvested from contaminated waters. Through a letter to 100,000 pediatricians, obstetricians/gynecologists, and family physicians across the nation, doctors were asked to advise their patients to pay attention to local fish consumption advisories. Doctors also received brochures aimed at the general public, written in English, Spanish, and Hmong (an Asian language), that describe how to safely consume fish and minimize exposure to contaminated fish. Copies of these brochures were sent in late 1998 to state and tribal environmental and public health professionals.

Environmental Justice and Children's Health Initiatives. As research has indicated that certain populations (e.g., those with high rates of consumption of contaminated fish) and children and fetuses (due to a higher vulnerability to harmful effects of toxic pollutants) may be disproportionately affected by environmental pollutants, EPA has developed several programs and offices to address this concern. For example, studies under the Office of Environmental Justice, the American Indian Environmental Office, and the Office of Children's Health Protection, examine issues such as awareness of fish advisories and patterns in adverse human health effects due to consumption of contaminated fish and wildlife. EPA has also begun to review and revise several of its risk assessment guidance documents to include further consideration of children's health. Dioxin is among the chemicals included in this risk characterization.

FDA Actions. As part of a sampling associated with its dioxin reassessment, EPA analyzed 80 chicken samples from 28 states and found that two of the samples had unusually elevated dioxin levels of 16.8 ppt and 19.2 ppt. This finding prompted a multi-agency traceback investigation to determine the possible cause of high levels of dioxin detected in the chicken samples. EPA, FDA, the Centers for Disease Control and Prevention, and USDA's Food Safety Inspection Service (FSIS) coordinated with state health authorities in the sampling effort. The traceback investigation, which focused on the processing of soybeans for feed ingredients, ultimately revealed that the source of the contamination was bentonite (commonly referred to as "ball clay"), a conditioning agent added to soybean meal to prevent caking. The bentonite was traced to a single clay mine in Mississippi. At the request of FDA, the mine stopped shipping this substance for use in animal feed. Although there was no standard or tolerance level for dioxin-like chemicals in feed or food, FDA issued a notice on July 7, 1997 telling commercial catfish and egg producers not to ship human food products from or by animals who may have eaten animal feed contaminated with dioxin. While the levels found in eggs and catfish presented no immediate public health hazard, FDA considered this a prudent step to protect the public health.

5.3 Information Gathering and Monitoring Efforts

5.3.1 Dioxin Exposure Initiative Efforts

In September of 1994, the United States Environmental Protection Agency (EPA) released its public review draft of the Dioxin Reassessment and announced that it would initiate a Dioxin Exposure Initiative (DEI) to fill critical data gaps regarding the sources of dioxin that contribute to human exposure. The DEI was identified as a multi-year effort that would extend beyond the current reassessment effort; however, particular emphasis would be placed on gaining as much information as possible that could be incorporated into the final reassessment. This data will also be critical to supporting EPA development and implementation of an agency-wide dioxin risk management strategy. The DEI is jointly funded and managed by EPA's Office of Prevention, Pesticides, and Toxic Substances, and the Office of Research and Development.

The fundamental goal of the initiative is to quantitatively link dioxin sources to general population exposure. This is being accomplished by pursuing two simultaneous lines of inquiry. One approach is to focus on identifying sources of dioxin-like compounds and work forward along their pathways of transport and deposition. The second is to start with human body burdens and work backwards through the process of bioaccumulation and uptake. As these two lines of inquiry merge, they should provide an adequate understanding to enable EPA to target future exposure reductions efforts to those sources and pathways that most significantly contribute to human risk. An additional goal of the initiative is to estimate, where possible, past trends in dioxin exposure and to establish a current baseline for monitoring future trends. Numerous studies have been initiated under the DEI, some of which are listed below.

Sources

National Dioxin Ambient Air Monitoring Network. Under the U.S. EPA Dioxin Exposure Initiative, the National Dioxin Ambient Air Monitoring Network (NDAMN) was established to provide a nationally-based, long-term, ambient air monitoring network for dioxins. Specifically, NDAMN is intended to: 1) provide ambient air data useful for calibrating regional-scale long-range transport models used in estimating air concentrations of dioxin as a function of dioxin source emissions; 2) provide air monitoring capability for the occurrences and levels of dioxin-like compounds in areas where domestic livestock feeds are primarily grown; 3) provide for the long-term monitoring of dioxin-like compounds in different regions of the United States, and over different seasons; and, 4) provide data on potential transboundary import of CDDs/CDFs into the United States.

Evaluation of emissions from open burning of household waste in barrels. In response to considerable uncertainty associated with dioxin and furan emissions from "backyard" burning of domestic waste, EPA is conducting a series of ongoing studies to evaluate emissions from this source. In order to begin the process of more adequately characterizing this source, an initial series of barrel burn tests using domestic waste was conducted and results released in the 1997 report, Evaluation of Emissions from the Open Burning of Household Waste in Barrels (Lemieux, 1997). With the intent of developing a more complete understanding of the causal factors behind barrel burn emissions, additional rounds of testing have been conducted, with results expected in 2000.

Evaluation of releases from PCP-treated utility poles. Due to low levels of dioxin contamination, pentachlorophenol (PCP) treated wood has been hypothesized to represent a large reservoir source of dioxins which may be released to the air by volatilization or to surrounding soils by leaching. In response to the lack of reliable data on releases of dioxins and furans from PCP-treated wood, EPA initiated and completed an evaluation of releases from PCP-treated utility poles, which are estimated to comprise about 80 percent of the PCP in in-use wood products (USEPA, 1996 as cited in Winters et al., 1999). Results of the study supported the hypothesis that utility poles can serve as a reservoir source for certain dioxin congeners, although the need for more work was cited to be necessary before definitive explanations can be

developed or emission factors established. Additionally this study was limited in that it only addressed dioxin mobility during a pole's useful life, and did not address the question of dioxin mobility or environmental release as a result of pole disposal practices.

Exposures

Assessing and Modeling of Incinerator Impacts. Under the DEI, EPA has also put forward research efforts to evaluate local impacts from emissions of dioxins from a municipal solid waste incinerator known to have been emitting large amounts of dioxins prior to its closure. Data gathered in this project also allowed for the testing of EPA's ISCST3 air dispersion / deposition model. Critical model inputs available for these tests included emissions testing, meteorology, measured air concentrations, and measured soil concentrations.

USDA/EPA Food Surveys. Under the DEI, several joint efforts were conducted by EPA and the United States Department of Agriculture (USDA), in an attempt to develop statistically designed national surveys of dioxin-like compounds in beef, pork, and poultry. In all surveys, 60-80 samples were randomly taken from animal slaughterhouses, and results were extrapolated to provide estimates of dioxin contamination in these food products on a national basis.

National Study on Animal Feeds. The purpose of this study will be to characterize feeds for cattle, poultry, and swine nationally. The components of feeds will be described, and samples of feed components will be taken in attempts to determine which components contribute the bulk of dioxin to these terrestrial food animals.

Mass Balance On Lactating Cows. This study, conducted jointly with USDA, entails the measurement of mass balance data (dioxins in feed, feces, milk, etc) on four lactating cows over three lactations, to verify that feed is providing the dioxins to which the lactating cows are exposed.

National Milk Study on PBTs. In 1998, EPA reported on the completion of a study to assess the national prevalence and concentrations of dioxins, furans, and dioxin-like PCBs in the general pasteurized milk supply of the United States. The publication on this study can be found on the Publications Page of the Dioxin Exposure Initiative. The study utilized the EPA Environmental Radiation Ambient Monitoring System (ERAMS) for collecting milk samples. A current study will revisit the ERAMS network for another round of sampling, but this time the list of compounds will expand beyond the dioxins and PCBs to include other persistent and bioaccumulative toxics (PBTs) such as mercury and PAHs. The precise list of PBTs to monitor for, the number of samples, and further design considerations, are currently being determined.

Background TEQ Exposures in the U.S. Estimates of average background exposures of Americans to dioxins, furans, and dioxin-like PCBs in the 1990s were calculated as part of DEI efforts. This calculation was derived by summing intake estimates resulting from

diet, inhalation, and soil ingestion. Since 1994, significant improvement has occurred in the data on dioxin concentrations in food and food.

Trends

Several studies were conducted under the DEI to help elucidate historical trends in dioxin concentrations in the environment and human exposures. These efforts included: a historical meat and milk sampling study, which located and sampled canned meats and dried milk from decades in the past to determine the temporal variability of dioxins in animal fats; a sediment core study, which was conducted jointly between EPA and the United States Department of Energy and measured for dioxin-like compounds in 11 lakes of the U.S.; and a modeling study focused on past exposures to dioxins, which consisted of the derivation and calibration of a model to predict past exposures to 2,3,7,8-TCDD.

5.3.2 Other Sources and Emissions Research

CAA §112(m) program, Atmospheric Deposition to Great Lakes and Coastal Waters (Great Waters Program). The 1990 Amendments to the CAA include Section 112(m), Atmospheric Deposition to Great Lakes and Coastal Waters, which call on EPA to establish research, reporting, and potential regulatory requirements related to atmospheric deposition of hazardous air pollutants (HAPs) to the "Great Waters". EPA's Great Waters Program coordinates activities to address the requirements of Section 112(m). Dioxin is a Great Waters pollutant of concern. The "Great Waters" referred to in this program are the Great Lakes, Lake Champlain, Chesapeake Bay, and specific coastal waters designated through the National Estuary Program and the National Estuarine Research Reserve System. EPA provides biennial Great Waters Reports to Congress discussing the current scientific understanding of atmospheric deposition and the health and environmental effects of toxic pollution, as well as EPA programs to protect human health and the environment.

Integrated Atmospheric Deposition Network. The Integrated Atmospheric Deposition Network (IADN) was established by the U.S. and Canada in response to evidence that atmospheric deposition plays a large role in determining the water quality of the Great Lakes. IADN was created as part of the 1987 amendments to the Great Lakes Water Quality Agreement and the implementation plan for IADN was signed by the two governments in 1990. In the early 1990s the Great Waters Program in the U.S. provided further support for IADN, and IADN has since been incorporated into Section 112(m) of the US Clean Air Act. IADN now consists of five Master Stations and 14 Satellite Stations designed to assess the magnitude and trends of atmospheric deposition of toxic substances to the Great Lakes and, where possible, to determine sources of atmospheric pollutants. Although dioxins and furans are not currently included in the suite of toxic substances analyzed at IADN sites, they have been cited as chemicals for methodology development within the program.

Air Characteristic Study. EPA's Office of Solid Waste is currently conducting the Air Characteristic Study to address the question of whether some industrial wastes should be classified as hazardous because of risks posed by their air emissions. The study goal is to estimate the maximum waste constituent concentrations that could be present in certain waste management units, such as storage tanks, land application units, landfills and waste piles, and still be protective of human health. There are 105 chemical constituents, including dioxins, being investigated under this study. The findings of this study are due in 2000 and are expected to assist EPA in determining the need for regulatory changes under RCRA and/or options for risk reduction from waste management units.

Utility Air Toxics Study. In February 1998, EPA issued a report on the public health impacts of emissions of air toxics from utilities that burn fossil fuels (USEPA, 1998b). The report identified 67 air toxics, including mercury and dioxins, in fossil fuel-burning utility emissions. Although uncertainties in the analysis exist, the results of the study indicated that there are some potential health concerns associated with dioxin emissions from utilities. As discussed in previous sections, EPA has delayed a determination as to whether emission controls are appropriate or necessary for utility boilers until the Office of Air and Radiation collects additional information. This information collection effort and any determinations are expected to be completed by December 15, 2000.

Great Lakes Regional Air Toxics Emissions Inventory. This project is a long-term U.S. and Canadian effort to provide basinwide data and improve decision-making capabilities by promoting consistency in data collection and analysis, establishing standard procedures and protocols, and developing an automated emission estimation and inventory system. This inventory will assist in the successful implementation of key provisions of the Great Lakes Toxic Substances Control Agreement, signed by the Great Lakes governors in 1986. The project began with an initial inventory report in August 1998 compiled using 1993 data for emissions from point and area sources of 49 air toxics pollutants, including dioxins and furans, in the Great Lakes Basin. The next Great Lakes Regional Air Toxic Emissions Inventory using data from 1996 will target 82 compounds, including dioxins and furans, that have been identified as significant contributors to the contamination of the Great Lakes.

5.3.3 Other Exposure and Effects Research

In the Second Great Waters Report to Congress, EPA has reviewed numerous studies which specifically identify dioxin as a possible endocrine disruptor in wildlife, and also list dioxin as potentially affecting the endocrine system in humans (USEPA, 1997b). Accordingly, EPA has also been directing several recent research efforts towards dioxin exposure and effects on human populations. For example, working with various governmental and non-governmental interests, EPA has recently developed a draft screening and testing approach for systematically identifying endocrine disruptors and quantifying their effects (i.e., EPA Endocrine Disruptor Screening Program). Additional efforts are discussed below.

National Research Council Report on Incineration. In October 1999, the National Research Council (NRC) released a report, entitled *Waste Incineration and Public Health,* in which the relationship between waste incineration and human health was assessed. The results of the study indicated that although compliance with MACT incineration standards will diminish the exposure of local populations to emissions, it is unclear what effect compliance will have on a metropolitan or regional scale, because little is known about the risks posed by collective emission from several incinerators. The report also identifies a need for better epidemiological research on the health risks associated with incinerators, and for better data on the level of emissions that occur during non-standard (i.e., start-up and shutdown) operating conditions. The report also recommends a number of other improvements regarding the operation and testing of incineration facilities.

5.3.4 Other Routine Monitoring Efforts

CWA §305(b) Monitoring Program. Surface waters and ground waters throughout the U.S. are monitored regularly to ensure that they are meeting the water quality standards appropriate to the intended uses. Data on water quality conditions of the Nation's waters, including the Great Lakes in particular, are collected and reported by States, tribes, and other jurisdictions to EPA every two years as required under section 305(b) of the CWA.

National Study of Chemical Residues in Fish. In 1987, the EPA Office of Water conducted the first national screening-level investigation (USEPA, 1992) to determine the prevalence of selected bioaccumulative pollutants in fish, and to correlate elevated fish tissue contaminant levels with pollutant sources. The Office of Water has initiated work on a new four year national study of chemical residues in fish tissue, which will statistically evaluate the incidence and severity of over 100 contaminants, including dioxins and furans, in fish tissue in lakes and reservoirs (selected according to a probability design) of the continental United States. Although the selected lakes and reservoirs do not include the Great Lakes themselves, many tributaries to the Great Lakes are included in the study. Fish sampling will be conducted on a national basis, August through October 1999, 2000, 2001, and 2002. Results will be released as soon as QA/QC is completed; a final report is scheduled for 2003.

National Health and Nutrition Examination Surveys (NHANES). Conducted by the Centers for Disease Control and Prevention's (CDC's) National Center for Health Statistics, NHANES traces the health and nutritional status of U.S. civilians. NHANES can be used to monitor trends in exposure relative to the baseline body burdens. EPA is currently considering funding assessment of dioxins for NHANES 1999.

6.0 DISCUSSION AND CONCLUSIONS

Status of Knowledge Concerning Sources

One of the primary limitations associated with the '98 Inventory, and every emissions inventory, is the degree of uncertainty associated with the estimations. These uncertainties may result from limited data availability to define emission classes, ascribe activity levels, develop emissions factors, and identify and classify sources, and/or from changes over time in emission factors, activity levels, and facility classifications.

In addition, as discussed in the peer review of the '98 Inventory, new, unsuspected dioxin sources and additional data for known sources may be found. Such sources and data could significantly alter the understanding of dioxin sources. In fact, some of the potentially largest dioxin sources were not identified in previous U.S. dioxin emissions inventories. Emissions from such sources as open trash burning and landfill fires, while at present poorly quantified, may prove a significant portion of the national emissions.

Likewise the issue of dioxins in products, some of which have been quantified for the first time and none of which have quantified releases to the environment, remains an area of uncertainty and potential importance. Of particular note is the ultimate fate of dioxins in pentachlorophenol-treated wood.

In spite of these limitation, the U.S. '98 Inventory represents the most comprehensive inventory of sources currently available. As discussed in Section 3.5, it covers more potential emission sources than other published emission estimates, and the relative ranking of sources in the '98 Inventory is similar to that in other published emission estimates. Across all estimates, incineration sources are considered to be the largest sources of dioxin and furans to air.

Progress Towards the GLBTS Challenge Goal for the U.S.

The U.S. challenge is to seek by 2006, a 75% reduction in total releases of TCDD toxicity equivalents from sources resulting from human activity. The challenge applies to the aggregate of releases to the air nationwide and to releases to the water within the Great Lakes Basin. The 1987 emission estimates of anthropogenic sources, when finalized, will be the challenge baseline for the 75% reduction.

Based on the '98 Inventory, the United States is clearly on track to meet the challenge goal by 2006. This is evidenced by the drop in mid-range estimates of total releases to air from 11,274 g TEQ/yr in 1987 to 2,745 g TEQ/yr in 1995 and by the drop in mid-range estimates of total releases to water from 356 g TEQ/yr in 1987 to 20 g TEQ/yr in 1995. The Agency has high confidence in the bulk of these and additional expected reduction estimates, as based on the closing of several MWC and HMIWI facilities which were known to be some of the largest dioxin and furan releasers. Additional reductions are expected as full compliance with existing

regulations on dioxin emissions is met. However, a quantitative assessment of exactly where the U.S. stands with regard to the challenge goal is still dependent upon the Final Inventory, which may include additional information that will impact the evaluation of progress on the challenge goal and new developments regarding the impact of what are currently listed as "preliminary order of magnitude" emissions.

Next Steps

The present report, in accordance with Steps 1 and 2 of the four-step analytical framework outlined by the Great Lakes Binational Toxics Strategy, has detailed the known dioxin sources, and relevant regulations and programs, according to the best available information at this time.

In accordance with Step 3 of the four-step process, the Agency will next analyze the available information on dioxin sources and regulations compiled in this report with the goal of identifying options that may offer opportunities for new or modified approaches, pollution prevention programs, or other alternative measures, which may accelerate the pace or increase the level of dioxin/furan reduction, taking into account cost-effectiveness. The results of this effort will be the scope of a subsequent "Step 3" Report: *PCDD (Dioxins) and PCDF (Furans): Reduction Options*.

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